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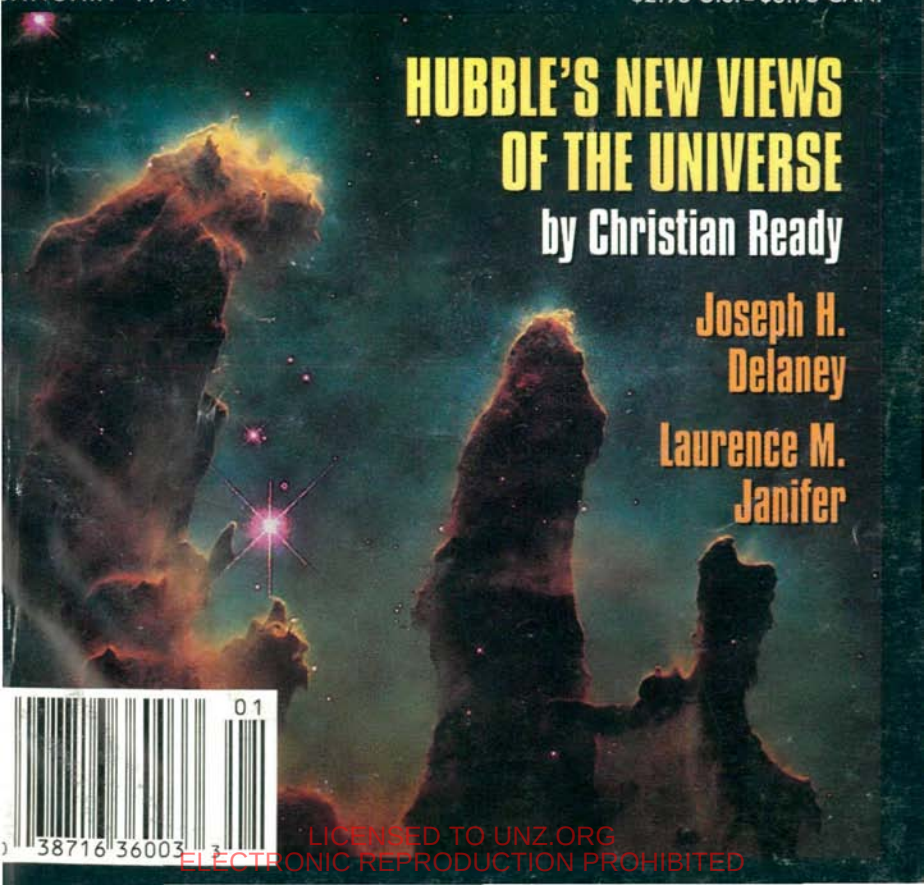

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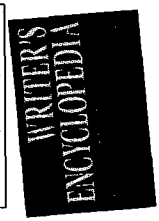

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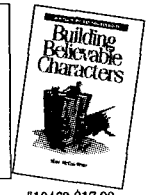

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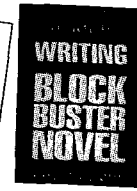

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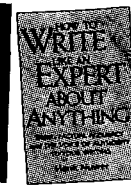

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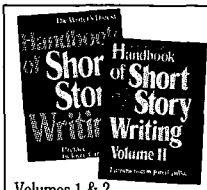

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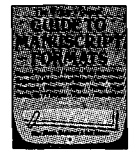

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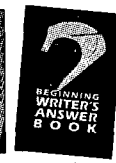

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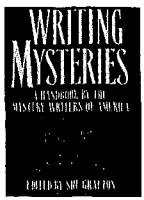

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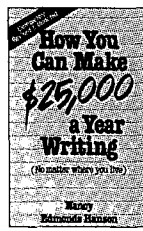

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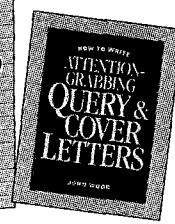

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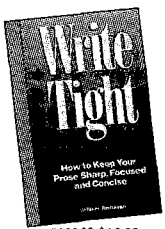

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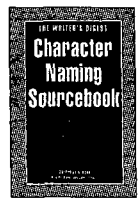

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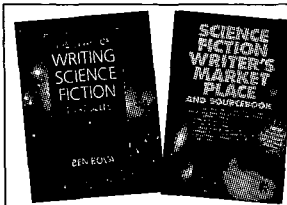

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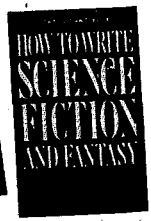

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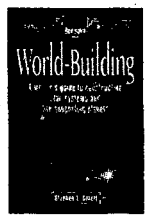

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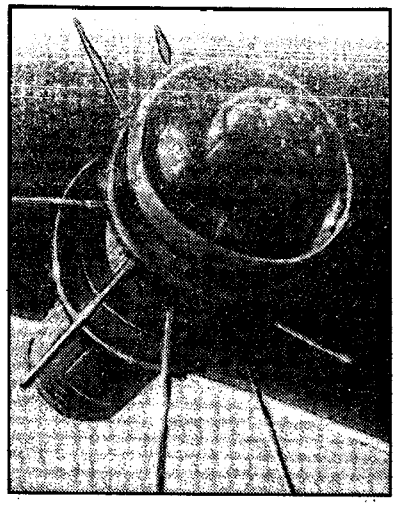

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TOO HARD?

Nanotechnology has been a familiar concept to *Analog* readers for about a decade now. K. Eric Drexler's book *Engines of Creation* was published in 1986. In case you didn't find it on your own, I called your attention to it in my November 1987 editorial, "Great Oaks from Little Atoms." The basic idea, that molecular-scale robots called "assemblers" might be able to build virtually anything that can exist, atom by atom, is so full of potential consequences for humanity's future that many science fiction writers have been quick to seize on exploring them.

A few recognizably nanotech-based stories, such as Greg Bear's "Blood Music," appeared even earlier, but in the last decade nanotechnology has become as pervasive a theme of science fiction as space travel or robots. The ramifications authors have explored span a spectrum from Kevin J. Anderson and Doug Beason's ominous *Assemblers of Infinity,* to Michael F. Flynn's whimsical "Soul of the City," to Marc Stiegler's expansively hopeful "The Gentle Seduction."

Which pretty well reflects the real range of promise and threat if the potentials of nanotechnology are as Drexler envisions them—and if real scientists and engineers achieve them.

So what's been happening in the real world?

Well, you *might* try to find out from Gary Stix's article "Waiting for Breakthroughs" in the April 1996 *Scientific American*—but, in my opinion, that would be a mistake. It pains me to have to say so, because I have long thought of *Scientific American* as a good layman's source of fairly in-depth information about what's going on in many fields of research, but this article seems to me to contain far too much opinion presented as factual reporting—and ultimately to give an impression that may be dangerously wrong.

On the face of it, the article is a factual account of the 1995 Foresight Conference in Palo Alto. The Foresight Institute is an organization established by Drexler and colleagues to promote the study of nanotechnology and its implications, and ways we might best prepare to take advantage of its potential benefits while avoiding its pitfalls. That's a kind of "foresight" we will very much need if those potentials develop as they might, and as fast as they might. The Institute has been hosting

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annual conferences at which scientists and engineers working in fields laying the groundwork for nanotechnology talk about their findings.

One might expect that a *Scientific American* report on such a conference would focus on the scientific and technological content of those presentations. Thus it was a bit jarring to find it opening by quoting a dentist pointing at Drexler and saying, "That's the messiah." Unfortunately, that pretty much sets the tone for the whole piece. Yes, it does occasionally quote some of the speakers at the conference—but the quotes are brief and less often about the substance of their work than about their philosophical disagreements with Eric Drexler.

Stix's bias is quite clear in both his selection of quotes and his personal comments. He seems to be trying his best to make Drexler look like a wild visionary whose "fanciful scenarios" far exceed anything that will actually happen, and strongly (but without supporting data) suggests that more reputable scientists and technologists agree with him than with Drexler. Heavily stressing the difficulties of detail being encountered by experimentalists, he largely ignores the significance of the fact that many of them thought enough of the subject to *do* the work and to go to this conference. He concludes by comparing aspirations toward general assemblers to what Richard P. Feynman called "cargo cult science."

Needless to say, folks at the Foresight Institute were not amused. They published a brief critique, in my opinion right on target, in Foresight Update No. 24—mentioning, among other things, that Feynman's son, Carl Feynman, "has written a letter to *Scientific American* objecting to their misuse of his father's essay." They have also posted an in-depth rebuttal by Ralph Merkle on the World Wide Web at http://www.foresight.org/SciAmResponse.html (though of course I can't be sure whether it will still be there by the time you read this).

Disturbing as some of us find the nature and tone of the *Scientific American* piece, that is not my main concern at the moment. What I want to comment on is the kind of controversy that exists about the extent to which nanotechnology is achievable. Controversy *does* exist, of course; Stix at least got that right, even though I am unconvinced by his portrayal of its nature and extent. Such controversy

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always exists in a radically new field of study.

And there are always difficulties with the details. Stix says, "What inspires actual researchers at the nanoscale is infinitely more mundane than molecular robots—but also more pragmatic." Skipping over the misuse of the term "actual researchers" (if it really only meant lab types, we'd have to exclude a lot of exceedingly important researchers, such as Einstein and Fermi), I'll say only, "Of course it is." This field is very new and, as the old saw says, you have to walk before you can run.

The fact that researchers are having trouble doing much simpler things than Drexler's long-term vision of a radically transformed future in no way proves that vision invalid. It may simply mean that we're not yet ready for any but the simplest parts of it—and that, for reasons that Drexler spelled out quite clearly in *Engines of Creation,* could easily change much faster than the workers in any one field might expect. (It could, of course, conceivably turn out that there *are* obstacles that can't be overcome—but that has by no means been proved so far.)

It's hardly surprising that the people doing the hands-on work on a frontier are likely to be much more conscious of the immediate difficulties than the long-term possibilities. I seriously doubt that many early American frontiersmen and women were thinking about anything resembling modern American civilization, with its interstates, internet, and jet airplanes. They were much too busy trying to survive in a wilderness. But each generation made a little advance here and a little advance there, and since each could build on the gains of its predecessors, the process moved

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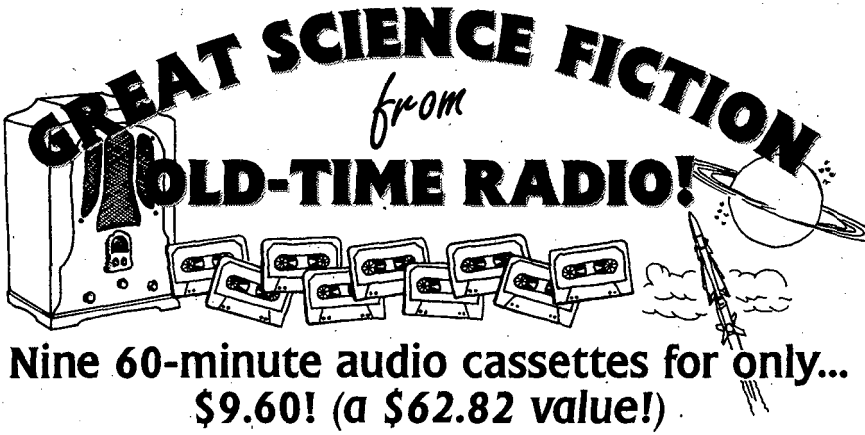

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faster and faster. So, hard as our great-great-grandparents might have found it to imagine, we *did* get where we are now—and we haven't stopped.

Scientific research is not *exactly* like settling a physical frontier, of course, any more than settling one frontier is exactly like settling any other. But there are similarities. The people who made the first vacuum tubes, early in this century, had plenty of trouble just getting them to work in quite simple circuits, and felt justifiable pride whenever they found a way to make them work a little better. At each stage, an experimenter with an idea might see one improvement he could reasonably aspire to making with the time and resources he had available. If you had described to him the tiny, powerful, ubiquitous computers of the late twentieth century, or the huge, sophisticated communications networks of the same period, he probably would have found it hard to believe you were serious. If you were his boss and told him he had to *build* one of those computers, he would have had little choice but to give up in despair. He would have had no idea how to do it, and no reasonable chance of learning. But he *could* take small steps on which others could build, and still others could build on those, and in mere decades those computers and networks were not only real, but taken for granted by millions of people.

Similarly, I doubt that the Wright brothers or many of their contemporaries imagined just how far their pioneering steps in aviation might lead. If you had described the Concorde supersonic transport and told Orville and Wilbur to build one, they probably would have told you it was impossible. It was—for them. But it was—eventually—quite reasonable for the industry that grew from the seed they planted.

And such things grow much *faster* now than they used to, because of the number of people working in fields that can help each other synergistically, and because of the enormously increased ease and speed with which those people can now talk to each other.

Gary Stix is undoubtedly right that there are some experimenters working on embryonic nanotech projects who have trouble imagining that the field will ever progress to anything like the state Drexler and Merkle describe. But I have a strong hunch—though of course I can't prove it—that they are modern-day counterparts of turn-of-the-century bicycle repairmen trying to build the first crude flying machines. Unlike those bicycle repairmen, somebody has described to them in considerable detail what an SST can be—and they find it hard to believe.

But they're still taking those first halting steps—and some of them *do* understand that what eventually develops may go far beyond what they can presently imagine in detail.

Somebody once said something like, "If an old, respected scientist tells you something is possible, he's almost certainly right. But if an old, respected scientist tells you something is *impossible,* he's very likely wrong." History is full of highly regarded sci-

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entists either saying that such things as airplanes, spaceships, telephones, and home computers either were impossible, or that they would have no commercial importance.

Surely that's something to bear in mind in listening to debates about how far nanotechnology can go. Let's just hope that everybody doesn't get so discouraged by the immediate difficulties at each early step that they give up on the ultimate goal.

And let's hope that the Foresight Institute keeps trying to look ahead at what this stuff can do for and to us—and what we can do about it. We just may need that knowledge a lot sooner than some of us think. □

Old books are books of the world's youth, and new books are the fruits of its age.

—Oliver Wendell Holmes, Jr.

The best thing about a good education is that you're always in on the joke.

—Sharah Thomas

Camelopardus is a large but extremely dull constellation between Ursa Major, of the great Dipper, and Cassiopeia, that zigzag thing that looks like a W or an M. Camelopardis is supposed to resemble a Giraffe, or Camelopard, but it really doesn't, unless you happen to be thinking of a Giraffe at the time.

—Will Cuppy

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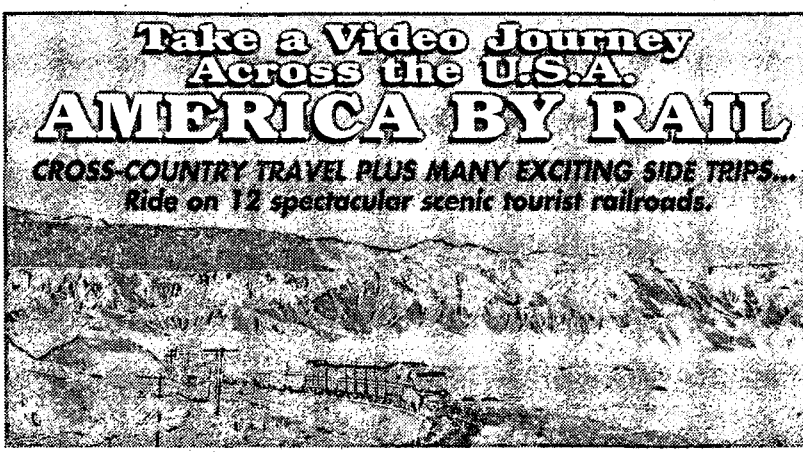
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Christian Ready

HUBBLE'S NEW VIEWS OF THE UNIVERSE

The Hubble Space Telescope is perhaps the greatest single achievement in astronomy. Hubble was launched in April, 1990 by the Space Shuttle *Discovery*. With this single telescope, astronomers can see clearer and deeper into the Universe than ever before.

Hubble orbits some 340 nautical miles above Earth; onboard is an array of sensitive instruments. They are the Faint Object Camera (FOC), the Wide Field and Planetary Camera 2 (WFPC2), the Goddard High Resolution Spectrograph (GHRS), Faint Object Spectrograph (FOS), and the Fine Guidance Sensors (FGS). With these powerful instruments, precision optics, and unique vantage point above the obscuring atmosphere, Hubble sees with a resolution some 10 times greater than the most powerful telescopes on Earth.

From the beginning, despite the much-publicized flaw in the primary mirror, Hubble has provided astronomers with views unprecedented by telescopes on the ground. When Hubble was restored to full optical capability in December 1993, its full potential was realized. Hubble continues to yield new discoveries, confirmations of theories, and new questions about the nature of the Universe itself. In this article, we will examine just some of the accomplishments of the Hubble Space Telescope.

Our Solar System—And Others

Venus is the innermost member of the Solar System to have been viewed by Hubble (Mercury is too close to the Sun's light to be safely detected by the spacecraft's sensitive instruments). By seeing Venus in ultraviolet light (another capability that is unique

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to a space-based observatory), atmospheric features come into view. The most intriguing of these features is a large horizontal Y-shaped feature that may be some kind of atmospheric wave. Such detail has not been seen in Venus's atmosphere since the Mariner 10 and Pioneer Venus missions in the 1970s.

Darker regions in Venus's atmosphere indicate concentrations of sulfur dioxide in the cloud tops. The Venus Pioneer probe first detected sulfur dioxide in the late 1970s. Since this gas is a primary output of volcanoes, it is believed that Venus experienced large-scale volcanic activity in the 1970s. The Hubble observations show that the sulfur dioxide levels continue to decline, however. This suggests that Venus has not experienced any large-scale volcanic activity for at least the last several years.

While Venus is an example of a planet with an overabundant atmosphere, Mars is a world near the opposite extreme. When the Viking probes investigated the surface of Mars in the 1970s, it was generally believed that the weather at the landing sites was typical of Martian weather in general. Over the last couple of years, however, Hubble observations indicate that the global temperatures are twenty degrees lower than they were during the Viking landings. Dust storm activity has diminished, leaving the atmosphere clear and cool, while clouds transport water from the northern ice caps to the southern polar regions. An abundance of ozone in Mars' atmosphere also indicates that it's colder and drier than before. This sort of weather may be typical for Mars, while the temperatures at the time of the Viking landings may have been abnormally high.

In a real sense, Hubble is very much a weather satellite for other planets. This is especially useful for scientists who wish to send probes to these planets. Just as an airplane pilot is very interested in the weather at her destination, so are mission coordinators interested to know about the weather conditions at other planets.

This principle was very recently applied to the Galileo mission to Jupiter. Using the Wide Field and Planetary Camera 2 (WFPC2) on Hubble, a team of astronomers imaged the predicted entry point of Galileo's re-entry probe. These images showed what the conditions were like at the time and place of the probe's insertion into the Jovian atmosphere.

Hubble's observations of Jupiter's four largest moons (the so-called Galilean satellites) reveal surprising new insights into these "mini-worlds." Images of Io, the innermost of these four primary satellites, show that a small spot surrounding the volcano Ra Patera has grown into a 200-mile diameter light-colored feature. These changes reveal dramatic volcanic activity in the last year. Astronomers are now waiting for data from the Galileo orbiter to tell them more about this recent volcanic activity.

Hubble discovered a very faint oxygen atmosphere on Europa. While the surface pressure on Europa is less than one-hundred-billionth that of the Earth, this observation does make Europa the only known satellite to have

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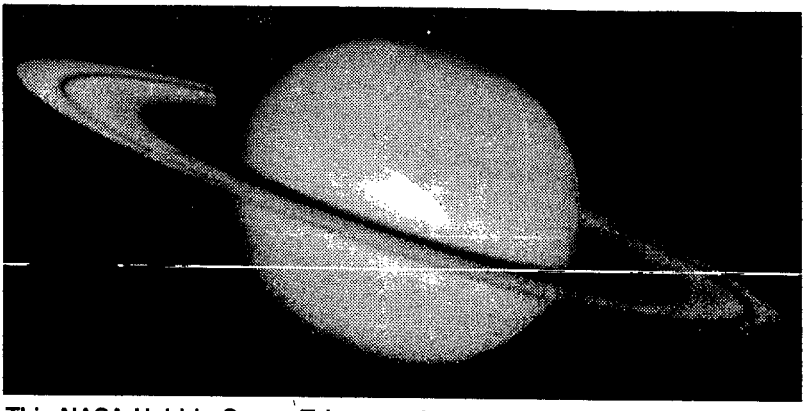

This NASA Hubble Space Telescope image of the ringed planet Saturn shows a rare storm that appears as a white arrow-head shaped feature near the planet's equator.

Photo credit: Reta Beebe, New Mexico State University, D. Gilmore, L. Bergeron, STScI, and NASA.

an oxygen atmosphere. Does this mean that life could exist on Europa? Most likely not. At -239 degrees Fahrenheit, Europa is far too cold to support life as we know it. Still, it is most interesting to find such an atmosphere on Europa, of all places. . . .

Hubble found traces of ozone on Ganymede's surface, and Callisto shows highlights indicating fresh ice on its surface. These may be the result of recent impacts from micrometeorites and charged particles from Jupiter's magnetosphere.

Of course, Hubble's most famous observations of Jupiter came in the summer of 1994, during the impact of the fragments of comet Shoemaker/Levy-9. As the comet drew closer to the gas giant, astronomers predicted the event would result in one of two possible scenarios: Either the comet fragments would burn up in Jupiter's upper atmosphere, or they would disappear beneath the cloud tops, never to be seen again.

What did happen was a spectacular surprise. The comet fragments plunged into the cloud tops and exploded within the upper atmosphere. These explosions released the energy equivalent of several million megatons worth of TNT and left Earth-sized "black eyes" in the clouds of Jupiter.

The aftermath of the comet impacts revealed even more surprises about Jupiter. Heavy elements such as iron, silicon, etc. were expected to have sunk deep into the planet long ago, leaving the lighter elements such as hydrogen and helium behind in the upper atmosphere. Hubble found—particularly at ultraviolet wavelengths—silicon, magnesium, and car-

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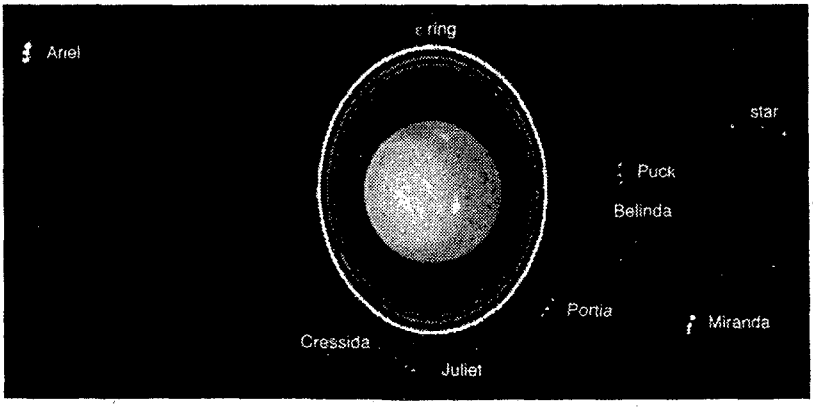
bon silicates in the wake of the comet explosions. These observations are causing astronomers to reconsider their views on the composition of Jupiter and other gas giant planets.

Saturn, with its spectacular ring system, does not boast an atmosphere as dynamic as Jupiter's. Nevertheless, Hubble observed spectacular new storms in Saturn's atmosphere. The most recent of these giant storms came in September 1994. The storm, about the size of the Earth (around 7,900 miles across) resembled an arrowhead turned on its side. The top of the storm consisted of ammonia ice crystals, giving it a lighter color than the rest of Saturn's atmosphere. It was created by an upwelling of warmer air, similar to a terrestrial thunderhead. Hubble's observations gave astronomers new insights into the details of Saturn's prevailing winds.

The atmosphere of Saturn's largest moon, Titan, is about four times as dense as Earth's. It is composed of nitrogen laced with methane and ethane. As a result, there is no way to visibly resolve its surface. At near infrared wavelengths, however, Hubble "saw" through the dense, smoggy atmosphere to reveal an Australia-sized (2,500 miles across) feature on the surface. This feature remains a mystery. It may be a landmass, a depression, or some kind of "hot spot." At the present time, however, there is no conclusive evidence as to what it really is. During the next servicing mission in 1997, the Near Infrared Camera and Multi Object Spectrometer (NICMOS) will be placed aboard Hubble. This instrument will allow Hubble to "see" better in the near infrared, allowing observers to peer through the thick atmosphere of Ti-



This NASA Hubble Space Telescope image of the planet Uranus reveals the planet's rings, at least five of the inner moons, and bright clouds in the planet's southern hemisphere.

Photo credit: Kenneth Seidelman, U.S. Naval Observatory, and NASA.

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tan more effectively, giving an even clearer view as to what this surface feature might be.

Future Hubble observations of Titan will be used to identify landing spots for a new space probe. In 1997, NASA will launch a new spacecraft, called Cassini, on a seven-year journey to Saturn. Like Galileo, Cassini will also carry a probe, called Huygens, which will land on the surface of Titan.

Hubble is studying the complex satellite system of Uranus for the first time since the Voyager 2 flyby in 1986. HST's continuing measurements of the satellites' motions will allow precise calculations of their orbits. This will in turn allow for a more precise determination of Uranus's mass, as well as a better understanding of the dynamics of its complicated satellite system.

Hubble allows for the surface brightness of Uranus's moons to be measured in different colors—each according to the "color" of various mineral compounds. As a result, the mineralogical composition of these moons are now being studied in greater detail.

Hubble observed a pair of high-altitude clouds in Uranus's upper atmosphere, again for the first time since the Voyager 2 flyby. Hubble is tracking the two clouds, 2,500 and 1,800 miles across, to measure the dynamic effects of the planet's atmosphere. Uranus, like the other gas giants, has no surface. Measurements of the motions of such clouds also allow estimations of the planet's mean rotation period.

When Voyager 2 explored Neptune in 1989, astronomers were stunned to find a world alive with a cold, raging, dynamic atmosphere. A large feature, called the Great Dark Spot, was discovered in Neptune's southern hemisphere. When Hubble examined Neptune again in June 1994, the feature had disappeared. The feature was essentially a hole in Neptune's methane cloud tops that opened a window to the lower levels of the atmosphere. This hole continuously changed shape as the atmospheric winds carried it around the planet. Therefore, since the feature was unstable, some researchers did not expect it to last too long.

Surprisingly, Hubble discovered a new dark spot at an opposite location in the northern hemisphere. Why this new spot should appear is not entirely certain, but this observation shows how radically Neptune can change its face over a very short time. Astronomers are eager to use Hubble again to keep track of this new feature and, for the first time, to conduct a long-term, detailed study of Neptune's atmospheric changes.

Hubble has made the first direct observations of Pluto and Charon. While it has been known since 1979 that Pluto has a companion moon, it wasn't until Hubble first looked at them that both worlds were resolved from one another. This allowed astronomers to make accurate measurements of the diameters of Pluto and Charon, at 1440 and 790 miles, respectively. Because Charon's diameter is about one-half that of Pluto's, the two worlds are considered to be a "double planet." By contrast, our Moon's diameter is

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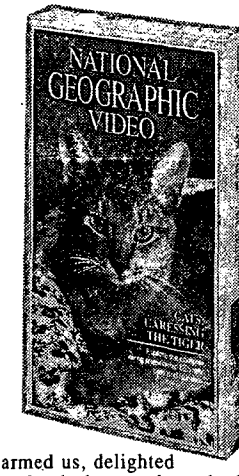

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only about one-quarter that of Earth's. Pluto and Charon are separated by only 12,200 miles.

Hubble has also made the first ever image of Pluto's surface. Several images were made during its 6.4 day rotation, and combined into a surface map of Pluto. Hubble reveals for the first time twelve surface "regions" that are either light or dark. There appear to be impact craters and basins on the surface. Most of the surface features, however, are probably due to frost regions which migrate across Pluto's surface. These frosts probably originate with the seasonal changes during Pluto's 248-year orbit.

Elsewhere in the Solar System, comet Hale-Bopp has been the subject of recent study for Hubble observers. This comet appears in Hubble images as a "pinwheel" pattern and a blob of free-flying debris near the nucleus. As comets get closer to the Sun, the crust begins to sublimate into a gaseous shroud around the comet. This new "blob" may be a piece of the comet's icy crust that has broken off during the surface evaporation.

Currently, comet Hale-Bopp is well beyond the orbit of Jupiter, almost 600 million miles away. Still, at this distance, the comet appears very bright. By 1997, Hale-Bopp could be the brightest comet of the century.

In order to understand how solar systems form, Hubble investigates nebulae such as the great Orion Nebula. Several images of Orion were assembled into a mosaic to produce one of Hubble's largest images. The result is a beautiful panorama of a star factory in production. Some 700 embryonic stars are seen at various stages of formation. Surrounding some of these "protostars" are large disks of material. These proto-planetary disks, or "proplyds," are anywhere from 0.1 to 730 times the mass of our Solar System. The disks are tilted at many different angles; some are seen face-on surrounding the central star, while others are seen edge-on. Our Solar System is believed to have condensed out of a similar disk of material surrounding the newly formed Sun some 4.5 billion years ago. These observations provide new clues about the origins of our own Solar System. Although it is likely that not all of these disks will form into planets, Hubble's observations show that solar system formation may be commonplace in the Universe, with some 153 examples forming in this nearby nebula only 1,500 light-years away.

The Orion Nebula mosaic shows a gaseous "spacescape" of walls and valleys of gas, composed mostly of hydrogen and helium. The nebula's four hottest and most massive stars, called the Trapezium, lie at the center of the nebula. These hot, young stars (about one million years old each) blast the surrounding nebula with intense ultraviolet radiation. As a result, the surrounding nebula fluoresces in a splendor of color. As some of these protostars form, high-speed jets of hot gas shoot out at 100,000 miles per hour. These jets plow into the surrounding nebula,

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carving bright loops and arcs into the nebula's walls.

The Life and Death of Stars

To better understand the process of star birth, Hubble is examining three newly forming stars in close detail. Each object is surrounded by a disk of material. As material from the disk spirals into the protostar, it speeds up and is ejected out along the poles of the system in a high-speed jet.

Three systems—HH-30 (Herbig-Haro Object 30), HH-34, and HH-47—are examples of similar stars at various stages of formation. Each image provides an increasingly expanded view, revealing the behavior of such jets at greater distances from the central protostar.

HH-30 shows a butterfly-shaped disk of material surrounding a forming protostar. Since this disk is spinning, it is believed that the outer edges will eventually flatten. Planets may someday form out of the flat, spinning disk. A jet of material emerges from within the disk, most likely from the central star itself. The jet remains confined to a narrow beam even out to a distance of several billion miles from the star.

Traditionally, jets were thought of as being smooth and continuous, but Hubble observations of the jet in HH-34 show a beaded structure. These beads are disk material, shooting out from the central star like bullets from a machine gun. These observations are surprising, suggesting that stellar construction may be fitful and episodic, with stars undergoing periods of violent growth.

HH-47 sports a much larger, three trillion-mile-long jet. The jet is very complicated, revealing swirls and irregular shapes. This pattern may be due to the fact that the star is wobbling, causing the jet to shoot out in a corkscrew-like fashion. The wobbling of the central star may be due to the gravitational interaction of an unseen companion star. The jets are capped at either end by bow-shaped shocks which glow as the jet slams into the surrounding interstellar gas.

Beta Pictoris is a well-studied example of a fully formed star with a 200-billion mile diameter disk of dust and gas seen edge-on. Hubble allows observers to explore the innermost region of the disk, which until now has been hidden from view due to the bright glare of the central star. Careful examination of the disk's edge reveals a slight warp. Such a warp should not be present if the disk were left to spin into a flat, pancake-like shape around Beta Pictoris. The only explanation for the warp is a small, orbiting object which has enough of a gravitational pull to distort the disk. Calculations based on the measurement of the warp suggest that a planet anywhere from one-twentieth to twenty times the mass of Jupiter is orbiting Beta Pictoris. This mystery planet lies somewhere within the five billion-mile-wide clear zone in the center of the disk. This zone has long been suspected of having planets that swept out the debris. Hubble's discovery, however, provides the first visual evidence that at least one planet surrounds Beta Pictoris.

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One of the most provocative, spectacular, inspiring, and eerie images ever taken by Hubble is that of the interior of the Eagle Nebula. Hubble's image of the central region shows three columns of dense molecular hydrogen, the largest of which is a light-year in length. Surrounding these columns are hot, newly formed stars that blast the region with ultraviolet radiation. Embryonic protostars embedded within the nebula are losing their gaseous cocoons due to a process called "photoevaporation." These diminishing shells are called "Evaporating Gaseous Globules" or EGGs. The EGGs themselves block some of the ultraviolet radiation from the hot stars. Some parts of the remaining nebula are kept intact as they are able to hide in the EGG's "shadow." The resulting appearance is one of gentle, gaseous tendrils reaching out from the columns to the unborn star's remaining cocoon. Eventually, the EGGs will be completely photoevaporated. The resulting stars will be much smaller than their hot neighbors, as they will have to form out of a rapidly diminishing supply of material.

A protostar needs to acquire a certain amount of material in order to get hot enough to begin thermonuclear fusion of the hydrogen in its core. Once thermonuclear fusion begins, the protostar shines as a true, "main sequence" star. If a protostar cannot accumulate at least 8% of the Sun's mass from the surrounding nebula, it cannot get hot enough to become a main sequence star. The end result is a cool "brown dwarf."

Brown dwarfs have been long thought to exist, but until now, they have never been observed. Recently, Hubble confirmed the first unambiguous observations (made at Mount Palomar observatory) of a brown dwarf. Hubble's observations show that the object, Gliese 229B, is much dimmer, cooler (no more than 1,300 degrees Fahrenheit), and less massive than previously reported brown dwarf candidates. Gliese 229B has a chemical composition very similar to Jupiter's, yet its mass is 20 to 50 times greater. This object is much too large to be a planet, yet far too small to be a star.

This discovery marks an important first step in allowing astronomers to distinguish between a brown dwarf and a large planet. Brown dwarfs are thought to form at the same time as their companion stars. Therefore, a brown dwarf is free to orbit the star as it likes, usually in an elongated, highly elliptical orbit. Planets, on the other hand, form out of a spinning disk of material. Therefore, planets should retain relatively circular orbits about the star. This is true of most of the planets in our Solar System.

Hubble observations of Gliese 229B's orbital motion around Gliese 229A will help settle the question as to the nature of this new object. The brown dwarf is roughly the same distance from its star as Pluto is from the Sun. Therefore, it will require many decades of observations before a true orbit can be calculated. Hubble has begun this project, but a future space telescope may be needed to finish it.

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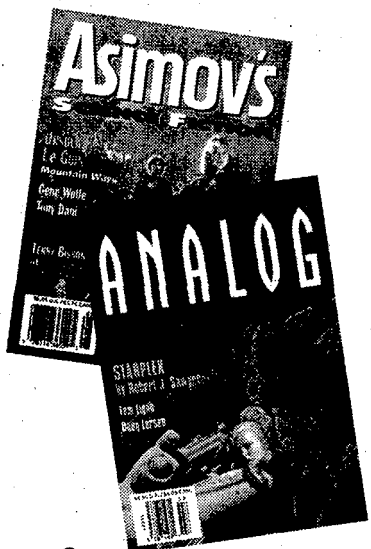

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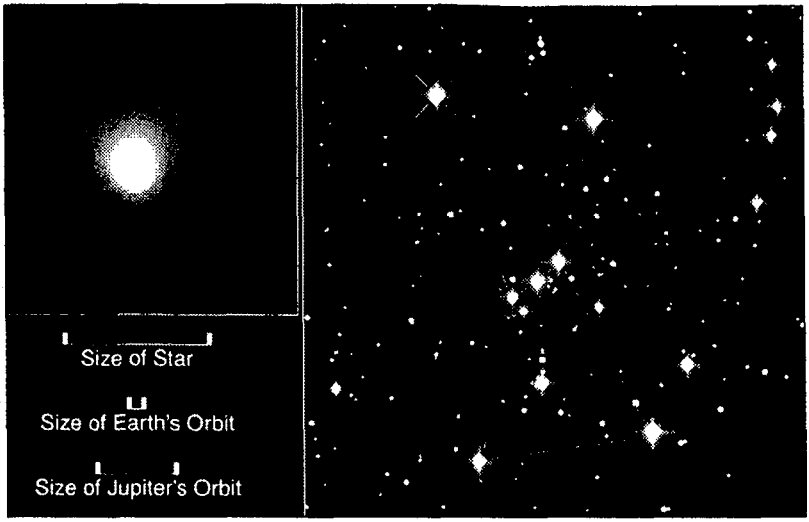

This is the first direct image of a star other than the Sun, made with NASA's Hubble Space Telescope. Called Alpha Orionis, or Betelgeuse, it is a red supergiant star marking the shoulder of the winter constellation Orion the Hunter, at right.

Photo credit: Andrea Dupree, Harvard Smithsonian CfA, Ronald Gilliland, STScI, NASA and ESA.

Once a star forms, it goes about life with relatively little change. Stars like our Sun spend the majority of their lives burning hydrogen into helium via thermonuclear fusion. The normal, main sequence stage of hydrogen burning typically lasts for about 10 billion years in stars like our Sun. Eventually, this supply of hydrogen will run out. When this happens, the star begins to evolve. Over the next several million years, the star's outer layers expand and cool down. The star expands to become a red giant.

Betelgeuse, in the constellation of Orion, is a red supergiant star in the late stages of its evolution. Hubble made the first image of the surface of this star. Indeed, this is the first time the surface of a star (other than the Sun) has ever been seen. Betelgeuse is considered to be a red supergiant star. If Betelgeuse were placed at the center of our Solar System, its atmosphere would extend past the orbit of Jupiter. Betelgeuse appears to have an oblong, non-spherical shape. Hubble also reveals a mysterious hot spot on Betelgeuse. Some 10 times larger than the Earth, it is at least 2,000 K hotter than the surrounding surface. There may be a link between this new feature and previously detected oscillations in the star's surface. Another

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possibility is that this feature may be carried along the star's surface by the powerful magnetic fields generated by the supergiant.

Stars like these continue to swell. Through various processes, they eventually eject their outer shells. Sometimes the material is shed over the course of several ejections, leaving vast, nested spheres of material surrounding the star's former core. This core, called a white dwarf, is only about the size of the Earth, yet burns at a temperature of some 40,000 K (by comparison, the surface temperature of the Sun is 6,000 K). The surrounding shells are illuminated by the intense radiation of the white dwarf. These so-called "Planetary Nebulae" are of interest to astronomers, because they provide clues about the late stages of a sun-like star's life.

With the insides of a star expelled in multiple layers, these objects provide astronomers with a "fossil record" of a star's evolution and dynamics during its death throes. A spectacular image of the Cat's Eye Nebula, made by Hubble in 1994, reveals a surprisingly intricate structure of material surrounding the central object. There are actually two white dwarf cores at the center. According to the model, the two stars in the binary system generated extremely fast stellar winds, blowing away layers of their former material into space. This process may have repeated itself, giving rise to multiple, nested layers. Surrounding these lobes of material is a larger, outer ring of material that may have been blown off at an even earlier phase. At right angles to the ring are a pair of high speed jets, which may have originated from one of the two stars. These jets create shock waves of material as they collide with the nearby interstellar medium. The jets are now pointing away from the shock fronts. Therefore, it is possible that the star producing these jets is wobbling about its companion, changing the position of the jets themselves.

Exactly how a red giant ejects material to create a planetary nebula is not yet entirely known. However, Hubble's observations of the Egg Nebula reveal a red giant (hidden from view by a surrounding dust cloud) in the process of ejecting material at a speed of 115,000 miles per hour.

This object provides astronomers with a rare glimpse into the actual process of stellar material ejection. Hubble shows multiple shells of dense gas surrounding the central star. This suggests that a planetary nebula is created by a repeating process, rather than one swift outburst. The layers themselves convey the 10,000-year history of mass loss of the red giant.

Piercing the gas shells are two jets of material which may be coming from the red giant, or possibly from a companion star. They are illuminated by blue light which is scattered by the surrounding gas.

Another beautiful, yet puzzling example of a planetary nebula has been found by Hubble. The object MyCn18 appears to have an hourglass-shaped structure surrounding a central region. The central region itself is actually a shell of material which surrounds the central star.

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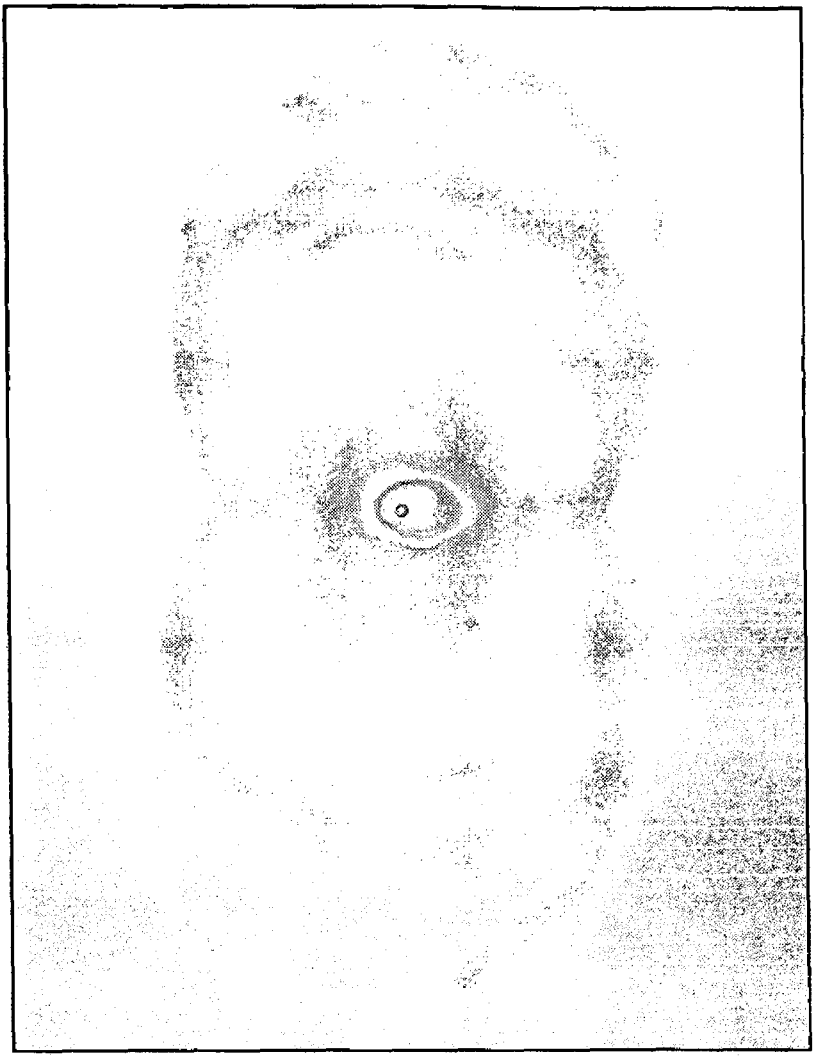

This is an image of MyCn18, a young planetary nebula located about 8,000 light-years away, taken with the Wide Field and Planetary Camera aboard NASA's Hubble Space Telescope.

Photo credit: Raghvendra Sahai and John Trauger, JPL, the WFPC2 science team, and NASA.

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The hourglass's "walls" are etched by swirls of gas. These features suggest that the hourglass formed as the result of a fast wind of material ejected along the poles of the star.

Strangely enough, the star is clearly off-center from the central shell. It is as if the star created the nebula and moved off. But what could make a star move? At this point, there is no conclusive explanation. It may be the result of an interaction with an unseen companion. Perhaps the star "pushed" itself out of the way as it created the nebula. Or it may be something entirely different.

Planetary nebulae were once thought to be very simple entities. Hubble's observations, however, reveal how complex these systems can be.

Stars more massive than the Sun live for a very brief time. Although they start off with a greater supply of hydrogen, their core temperatures are so hot that they burn it at a much faster rate than Sun-like stars do.

One of the largest stars known, Eta Carinae, has a mass estimated at 150 times greater than the Sun's. This stellar heavyweight shines some 40 million times brighter than our Sun. This star is very violent, prone to outbursts, and is literally tearing itself apart. Hubble shows material ejecting in two primary lobes at speeds of over two million miles per hour. This material is mostly nitrogen cooked up inside the core. Knots of material dot the lobes, each of which is larger than our Solar System.

Stars like these will ultimately self-destruct in a spectacular supernova explosion. Supernovae are the most powerful explosions in the Universe. Their intense heat creates all of the elements heavier than iron. These elements explode into space, enriching the interstellar medium with new, heavy elements that are incorporated into newly forming solar systems. Indeed, all of the gold, silver, nickel, etc. that we use here on Earth were manufactured in one or more supernova explosions.

One relatively nearby example is the remnant of supernova 1987A. Hubble studied the remnant shortly after launch and revealed a ring of material surrounding the compact, remaining object. This ring is probably composed of material left over from when the star originally formed. The central object—probably a neutron star or pulsar—illuminates the ring.

After its optical upgrade, Hubble discovered an outer double-ring structure surrounding the supernova remnant. Astronomers never expected to find such a structure. One possibility is that this star exploded in such a way as to create an hourglass-shaped lobe structure, and we are merely seeing the thickest edges of the lobes. Another possibility is that the rings are the illuminated parts of a vast outer cloud of exploded material that are being "painted" by a high energy beam of radiation or particles.

The rings, however, do not center on the central object. Therefore, their light source would have to be an unseen object next to the stellar remnant. This "mystery object" may be a second pulsar. On the other hand, it may be a black hole, giving off a bipolar jet of material as material close by

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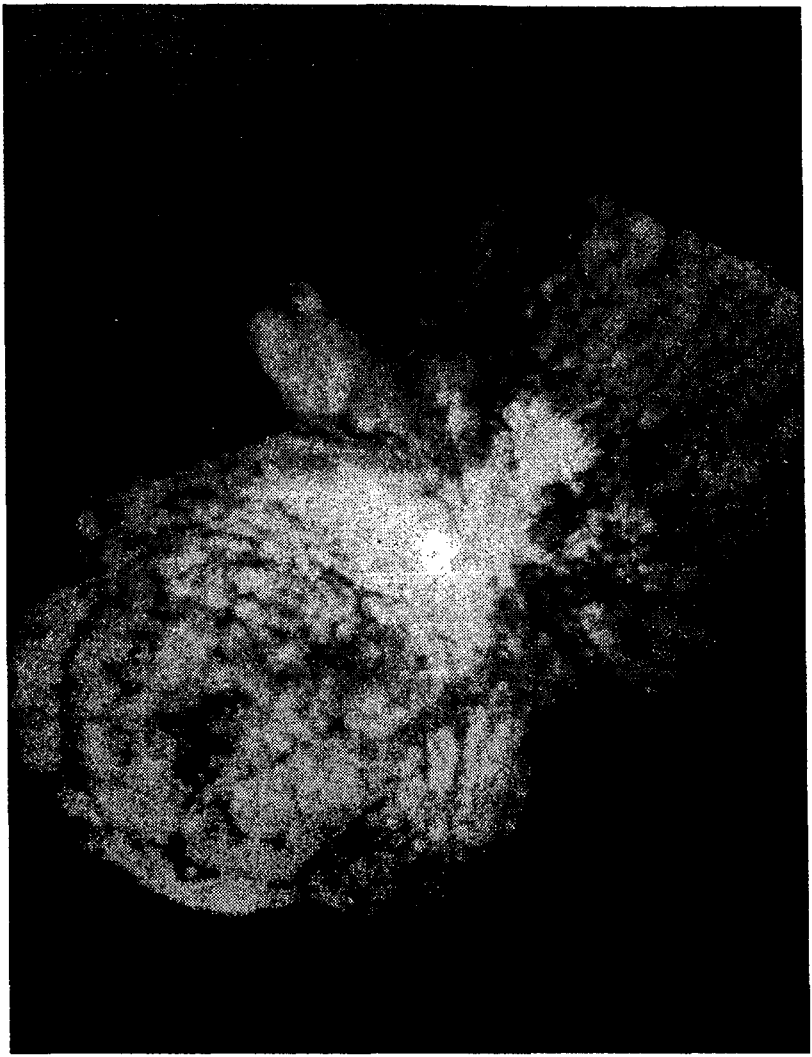

A huge billowing pair of gas and dust clouds are captured in this stunning NASA Hubble Space Telescope image of the supermassive star Eta Carinae.

Photo credit: Jon Morse, University of Colorado, and NASA.

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falls in, heats up, and gets accelerated along the poles.

The Age of the Universe: A Paradox?

Hubble is exploring globular star clusters to help answer some of the most fundamental questions about the age of the Universe. Since the Universe cannot be younger than its oldest stars, the oldest stars' ages can give a lower limit value of the age of the Universe. Globular star clusters contain the oldest stars in our Galaxy. By observing white dwarfs within these globular star clusters, Hubble is exploring a stellar graveyard. As white dwarfs age, they cool. By measuring the temperatures of these white dwarfs, astronomers are able to determine how old the Universe must be.

Hubble's initial searches in the globular star cluster M4 have found more than 75 white dwarfs. As more and more searches are performed with Hubble in different parts of the cluster, more white dwarfs will be found, and their temperatures measured. Thus, these stellar fossils can help to tell astronomers about the age of the Universe. So far, initial determinations place the age of the cluster, and hence the lowest possible age of the Universe, to be anywhere from 14 to 18 billion years old.

Another means of determining the Universe's age is to consider its expansion. Everywhere we look in the Universe, galaxies appear to be receding away from us. This phenomenon was discovered by astronomer Edwin P. Hubble. Mr. Hubble's observations showed that the Universe is expanding.

If we can measure the velocities and distances of enough galaxies, then we can work backwards to deduce the age of the Universe. The Hubble Space Telescope has given astronomers a powerful new tool for making such measurements because it allows more distant galaxies to be resolved. This capability is important because the farther one looks in the Universe, the more pronounced the expansion effect becomes. Thus, more accurate measurements can be made.

Astronomers can measure distances to nearby galaxies by searching for bright, pulsating stars called Cepheid variable stars. Cepheids pulsate with a well-known range of periods and shine at a corresponding range of brightness. Therefore, if one finds a Cepheid-type variable, one also automatically knows its true brightness. By comparing the Cepheid's apparent brightness with its true brightness, astronomers can deduce the distance to the Cepheid variable star. If Cepheids are found in another galaxy, astronomers can use them as cosmic yardsticks to measure the distance to the host galaxy.

Hubble made such observations by identifying Cepheid variable stars in the galaxy M100 in the constellation of Virgo. The Hubble observations of M100's Cepheids place this galaxy at a distance of 56 million ± 6 million light-years distant. This is the most distant galaxy for which such an accurate measurement has been made.

By comparing the distance of M100 to the velocity of its recession from Earth, a very clear and stunning new

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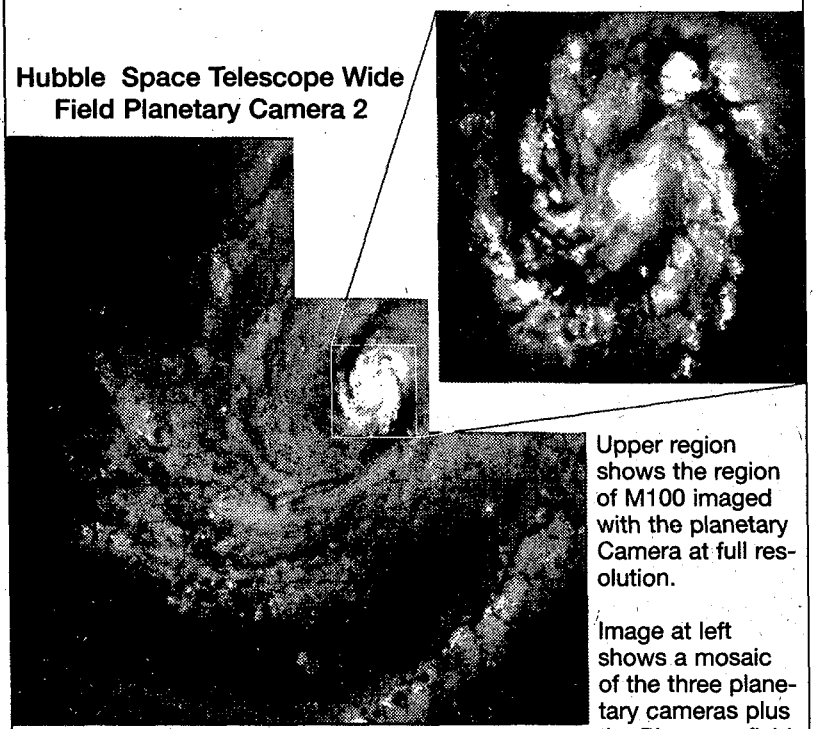
M100

A Spiral Galaxy in the Virgo Cluster

Hubble Space Telescope Wide Field Planetary Camera 2



Upper region shows the region of M100 imaged with the planetary Camera at full resolution.

Image at left shows a mosaic of the three planetary cameras plus the Planetary field camera.

An image of the grand design spiral galaxy M100 obtained with the second generation Wide Field and Planetary Camera newly installed in the Hubble Space Telescope.

Photo credit: NASA.

measurement of the age of the Universe has been made. Hubble's observation yields an age of 8 billion ± 2 billion years for the Universe, based on its expansion. However, white dwarf observations tell us that the Universe should be at least 16 billion ± 2 billion years old!

Can the Universe really be half as old as its oldest stars? At the very least, it is hard to believe. Certainly, one galaxy's observations would not

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be expected to firmly explain the age of the Universe. These initial measurements are so far off the mark, however, that they have become the cornerstone of a real conundrum in astrophysics.

To help settle this problem, it is desirable to measure the distance and recessional velocities of even more distant galaxies. Unfortunately, even Hubble has difficulty finding Cepheid variable stars at such great distances. Brighter objects, therefore, are needed in order to measure their distances. The problem, however, is that alternate "standard candles" are not as well understood as Cepheids.

The Coma cluster of galaxies is believed to be more than five times as distant as the Virgo cluster. This cluster may be around 250 million light-years distant, based on the 56 million light-year measurement for M100. The recessional velocity of these galaxies is much higher, as the expansion effect is more pronounced at greater distances from Earth. At farther distances, local gravitational attraction between cluster members is much less noticeable. Therefore, the observations are far less "compromised" by the apparent effect of local cluster motion towards each other. In order to make precise distance measurements, we need to find objects bright enough to be seen at this distance. These objects also need to have characteristics which tell us their real, or intrinsic brightness. In this way, we can calibrate a new standard candle by which to measure the distance to far away galaxies (and, ultimately, the age of the Universe).

A team of astronomers are using the Hubble Space Telescope to find out if globular star clusters can be used for this purpose. In the Hubble image of NGC 4881, the globular clusters, which contain 1,000 to 1 million stars each, are barely visible as pinpoints of light in the galaxy's outer regions. Only the brightest clusters can be used to standardize this new distance scale. Once identified, these clusters can be compared to the brightest clusters in our Milky Way to give some idea of their actual, or intrinsic brightness. To date, the brightest clusters have not yet been conclusively identified. There are still many more clusters to be counted with the addition of future images.

Hubble allows new measurement techniques to be tested on more distant objects. As newer distance indicators become standardized, the age of the Universe will be better known.

Black Holes and Intergalactic Collisions

Hubble is playing a definitive role in the search for black holes. Supermassive black holes have long been suspected of being at the cores of some of the most active galaxies. At the center of the Virgo cluster lies the giant galaxy M87. The largest galaxy known, M87 has an estimated stellar population of over 1 trillion stars. This particular galaxy has long been the subject of scrutiny because of two spectacular jets that show up very well in the radio part of the spectrum. The jets emanate from the core where a massive object appears to be fueling them.

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Hubble examined the core of M87, and found a spiral-shaped disk of material rotating around an unseen central object. By making velocity measurements of the inner disk, astronomers found that the disk was rotating at speeds of 1.2 million miles per hour. These measurements were used to gravitationally "weigh" the mass of the central object.

In order to sustain such a high speed whirlpool of gas, the object would have to have a mass of 3 billion suns, concentrated into a space no larger than our Solar System. Certainly, one could never actually see a black hole. Hubble's observations are showing us, however, that there is a 3 billion solar mass object occupying a very small region of space. This object is also very dark for a massive, compact object. In view of the evidence, a black hole appears to be at the center of M87.

Hubble has made another, even more perplexing, observation of a black hole at the center of another galaxy. NGC 4261 is very similar to M87 in that it has jets which are powered, according to Hubble observations, by a 1.2 billion solar mass black hole at the center. The black hole is surrounded by a disk which contains about 100,000 Suns worth of material.

While this new finding suggests that black holes may be commonplace at the centers of active galaxies, there is something unusual about the black hole in NGC 4261. The black hole appears to be some 20 light-years away from the geometric center of the galaxy. Assuming that the black hole was once at the center of the galaxy, what caused it to move?

One interesting idea is that the jets emanating from the black hole's disk might be acting as a kind of rocket engine. This exhaust may be powerful enough that, over time, it could gradually push the black hole around.

Another puzzle is the abundance of dust found in the 800 light-year wide disk surrounding the black hole. Dust is rarely seen in elliptical galaxies such as NGC 4261. Elliptical galaxies contain predominantly older stars, due to the lack of dust and gases needed to create new ones.

To find such a large concentration of dust in the core of this galaxy is therefore unusual. It is possible, though dynamically unlikely, that another, "dusty" galaxy may have collided with the large elliptical some time ago. Thus, the disk of material surrounding the black hole may be the remains of a former galaxy. There is enough material in the disk to fuel the black hole for the next 100 million years.

Perhaps such a collision displaced the black hole. Powerful new jets originating from the disk may have propelled the black hole away from the galaxy center.

The most dramatic example of an intergalactic collision observed by Hubble is the Cartwheel galaxy. Hubble reveals a stunning "ringworld" of explosive star formation, and two fleeing suspects of this intergalactic hit-and-run.

The Cartwheel was, presumably, a normal spiral galaxy not unlike our Milky Way. Then, a smaller, high ve-

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locity-galaxy crashed through the center of the giant spiral, like a rock thrown into a pool. The collision generated a powerful, 200,000-mile-per-hour shockwave that ripped through the galaxy, creating a firestorm of new star formation. The result is a ring of dust and star formation some 150,000 light-years in diameter. The ring is so large that our entire Milky Way Galaxy could fit well inside. The ring is littered with the blue fire of new, supermassive stars that would never have formed otherwise. Hubble also reveals immense loops and bubbles left behind by supernovae, going off like firecrackers, in the wake of the energy ribbon.

The galaxy itself is beginning to recover, displaying thin, spiral-shaped "spokes" reconnecting the center of the galaxy to the ring. These observations are giving astronomers the chance to glimpse a galaxy in the process of collision recovery, and to find out how the dynamics of spiral galaxies combine to give structure to these giant systems.

In this classic case of intergalactic "whodunit," two smaller galaxies are seen off to the side. While one of these two galaxies is undoubtedly the interloper, the Hubble observations do not provide any evidence incriminating either galaxy.

One of the two suspect galaxies appears to be distorted, and rich with hot, young, blue stars. This apparent activity strongly indicates that this galaxy must be the intruder. The second suspect galaxy, however, appears to be devoid of gas. This lack of material is consistent with the idea that such an intruder would be stripped of its interstellar gases while passing through the Cartwheel. While the case may not be closed on the Cartwheel galaxy, these observations provide new clues on the dynamics of galactic collisions.

Gravitational Lenses and the Past and Future of Everything

Hubble is using galaxies themselves as a kind of "telephoto lens" to study the Universe. According to Albert Einstein's theory of General Relativity, a sufficiently massive object will bend a beam of light around it. A massive galaxy, therefore, can bend, brighten, and magnify the light from the distant object. Thus, the galaxy acts as a "gravitational lens." Depending on the alignment between the objects and the mass distribution of the lens, the effect can result in arcs or even multiple images. In an extremely rare alignment, a distant galaxy can be lensed by a foreground galaxy into quadruple images.

Hubble recently discovered two rare quadruple gravitational lenses. The resulting images each show a galaxy with a cross-shaped pattern of objects surrounding them. The objects making up the cross are really multiple images of the same object lying behind the galaxy. By measuring the positions of the multiply-lensed images relative to the intervening galaxy, the distribution of the lensing galaxy's mass can be determined.

In this way, Hubble provides astronomers with a powerful new tool for measuring the mass distribution of

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galaxies. Once a sufficient sample of gravitational lenses is found, a mass distribution, or density, of the Universe can be extrapolated.

Knowing the density of the Universe is key to predicting its fate. If the density is too low, galaxies are too few and far between to maintain a strong gravitational attraction with each other. In this "open" model, the Universe will continue to expand forever. Stars will cease to form, as the supply of raw materials is used up by previous generations. Space and time will have no end. The Universe will eventually become a cold, dark plane of existence.

If the Universe turns out to have a sufficiently high density, the gravitational attraction between galaxies will eventually overcome their recession from each other. Thus, the "closed" model of the Universe predicts that the expansion will someday stop, and gravitational attraction will bring the galaxies closer together. The Universe will begin to collapse. The rate of contraction increases, as gravitational forces grow stronger. Eventually, the Universe collapses in on itself in a "big crunch." Space-time winks out of existence.

An intriguing possibility is that at the instant of the "big crunch," the Universe may rebound on itself, and explode in a new "big bang." Time and space flow forward, and the Universe begins anew. This raises some very philosophical questions: Have we been here before? Is this our first time around? Are events happening differently each time? If events repeat themselves, does that mean our futures are predetermined?

As Hubble looks deeper into the Universe to determine our future, it also looks farther back in time to reveal our past. Hubble made the deepest view of the cosmos ever seen in December 1995. For two weeks and 150 continuous orbits, Hubble imaged an otherwise vacant region in the Big Dipper. Hubble revealed a smorgasbord of galaxies, each at a different distance, and therefore, a different epoch in the history of the Universe.

The Hubble Deep Field shows literally thousands of galaxies at various stages of construction. This single image will take years to fully examine. Like an archeologist's dig, the Hubble Deep Field represents a cross section of the history of the Universe. Large spiral and elliptical galaxies appear in the foreground. Their light has taken perhaps only a few million years to reach us, and only appear a few million years younger than the modern day. Therefore, these galaxies are representative of the modern era of the Universe. Smaller, indiscernible smudges of stars and gas are abundant in the background. These are the most distant galaxies ever seen. These galaxies are so far away, their light has taken as much as eighteen billion years to reach us. Hence, these objects provide us with an image of a Universe only one-tenth its present age. In reality, all of the galaxies in the image, and indeed the Universe, are living in the modern era, and are shaped like their nearby counterparts. Thanks to the finite speed of

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light, however, we are witnessing the Universe play out its history before us.

Follow-up observations from astronomers all over the world are taking place right now to measure these distances as accurately as possible. When complete, the Hubble Deep Field will allow astronomers to witness the formation of the Universe itself.

Hubble allows us to view the past. Literally, we are watching events that happened long ago playing out before our eyes. At the same time, Hubble peers outward to the future of the Universe, and, for humankind, the future of our knowledge.

Hubble is helping to answer some of the most challenging questions in astronomy. At the same time, new, even more complex questions are being raised. Humankind's knowledge of astronomy is some 6,000 years old. The Hubble Space Telescope is showing us that our understanding has only just begun. ■

About the Author:

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A senior technician in an industry that suddenly evaporates to nothing finds himself in an unusual position.

—Nevil Shute

You can't depend on your judgment when your imagination is out of focus.

—Mark Twain

It takes little talent to see clearly what lies under one's nose, a good deal of it to know in what direction to point that organ.

—W. H. Auden

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LAST OF THE SOFT THINGS

This story is entirely fictitious, and any resemblance to real cultures or events is purely . . .

When young Amy Walters bit the nose off her stuffed bunny, Puff, and swallowed it, she had no way of knowing that she was about to change the world.

Mom Walters was lounging in the fat chair with a bag of Oreo cookies. She looked at the baby, who was suddenly quiet. "Bob, does the baby look funny to you?"

Bob put his beer can in its ring/stain on the lamp table, then unslouched and took a look. "Is this a trick question?"

"I mean, does she look . . . blue?"

"Everything looks blue. The TV's on."

Amy made a weird little choking sound, and Mom Walters flurried into action. She ran in circles around the room, screaming, "Oh my God!"

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Bob got up, patted the baby on the back, and the bunny nose popped out. It stuck to the carpet, covered with drool. The baby seemed surprised. She thought about crying, then decided it wasn't worth it, and snuggled against Bob's chest instead. The crisis was over.

Mom Walters kept orbiting the sofa, waving her arms. When Bob calmed her down she spoke frankly. "Somebody's going to *hear* about this!"

Donald Wheaton ran a clean business. He tried to keep his employees reasonably happy, though they were a demanding lot. As a child he had wanted to be an astronaut, like all the other kids, but after way too much school, the National Astronaut Waiting List was 10,000 pages long and there hadn't been a mission in years. So he had to swallow his pride and get a real job. The first few years were rough, and he ended up living off of his doctoral thesis, which wasn't so bad with milk and strawberries on it. He always thought of it as corn flakes with little letters typed on the back. After several uneventful jobs, he grabbed a bank loan and started his own business: FooCo, manufacturer of "Fine Smooshy Things for Kids." He employed 850 people, and had quite a reputation among the soft toy community.

His secretary, Jeremy, rapped on the door, then came into the office with a stack of mail.

Jeremy plopped the mail down on the desk. He knew the boss was just hanging around, spacing out, but he never had the nerve to say anything about it. "Uh, that top one came registered. Looks important."

Don peeked at the envelope. It was from the District Attorney. He immediately felt a twinge of anti-curiosity. The last thing in the world he wanted to do was to open that envelope. He ran a good business. He was careful to make only smooshy things, because his legal advisor said solid objects were too risky. Now . . . why would the DA want to talk to him?

Don waved Jeremy out of the room, then stared at the envelope from three hundred different angles before taking a heavy breath and tearing it open.

He was being sued by a Stocktown group called Parents Against Lethal Crib-Things (a non-profit corporation), founded by Mom Walters.

His first reaction was natural: "Funny name for a mother," he muttered. Then he realized that he was doomed.

The court battle was short and senseless. In the excerpts that follow, FooCo was represented by its legal advisor, Mac MacDonald, who tried his best to make sense of the accusations.

FOO: Because your daughter choked briefly on the severed nose of a FooCo bunny—one unit out of 400,000 sold—you are demanding the recall of every single unit sold to the public?

Would you explain your reasoning here?

MOM: They're dangerous.

FOO: Did your child suffer any injury which might support your claim?

MOM: She choked! She could not breathe for almost an hour! Who

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knows what damage that might have caused to all those little growing brain cells?

FOO: Did you say "almost an hour"?

MOM: Well, I wasn't exactly timing the episode. My stopwatch was in the bathroom.

FOO: According to your husband, the episode lasted less than fifteen seconds. Doesn't that seem more likely?

MOM: He's a pain in the ass.

FooCo brought in a forensic expert who argued that "during the course of development, the average child chokes on an average of 300 objects, 10 percent of which are larger than a bumblebee, and 0.004 percent *are* bumblebees . . . in summary, by the age of six, ordinary respiratory pauses included, a child spends 2,120 hours not breathing. The effect of an extra fifteen seconds can be seen as less than significant."

FooCo lost the battle, of course. When more than 1/20 of a mother gets worried, the corporate sector has no chance. The verdict was short and direct, "Find every Mr. Bunnyhead in existence, and burn them."

The recall took twenty-seven months, $1.3 million, 700 investigators, 85 Bunnyhead-seeking dogs, and a sneaky campaign of Easter bunny-trading. When they finally reported 99.99 percent recall, the State demanded better. "You mean that there are enough bunnies left out there to slaughter almost 0.0004 children?"

Mac checked his notes. "That's 0.00027 children, according to the latest statistics from the Bunnyhead Threat Studies Commission."

The State was firm. "Find them, or suffer the consequences."

"Consequences?" Mac thought, as he left the court building. "Imagine that!"

The last bunny was located in a landfill outside of Upside, Michigan. Mysteriously, it was in a trash stratum which local archaeologists dated at about 1964. Yet its remains were positively identified, using standard DNA fingerprinting. The recall was finally over.

For the first time in years, Donald Wheaton could relax. The long ordeal had cost him his wife, his membership in the Politically Correct Toymakers Guild, and years of media smearing.

He was gray, and his stomach was wracked with ulcers, but he tried to keep his cheer. After all, his only crime was wanting to give kids something to hug.

"Are you sure this last . . . thing . . . was actually a Bunnyhead?" he asked Mac.

"The DNA test said it was either a Bunnyhead, or an escaped convict from Detroit. Judging from the body mass of 122 grams, the convict matchup was considered spurious."

Donald had to crack a smile. "I love it when expensive technology provides nice clear answers."

"It's a good thing you decided to stuff the toys with down, instead of some synthetic fiber. Otherwise there wouldn't have been any DNA to play with. Good thinking."

"Actually, I used down because a local manufacturer went out of business, and we could buy several tons

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of the stuff cheap. Plus it's naturally soft and harmless."

Mac looked less happy than before. "Oh."

Donald clapped his hands together. "Cheer up! It's finally over!"

Later that day, nauseated from the stench of 402,331 roasting Bunnyheads, Don invited his forty-two employees (all that were left) into the company meeting room, and unrolled the blueprints for Bunnybaby.

"As you know," he announced, "we've had some time to develop a revolutionary new bunny-nose glue. We used it on our PandaThing last year, and so far, we've had no trouble with it. But kids *like* bunnies, and if we're going to get back on the market, we need to get a new bunny in production, so let's get on it. Bryan," he patted his R&D man on the shoulder, "says he can have the stuffers configured by Friday."

Bunnybaby hit the streets in March of 1997. Children everywhere, riding in shopping carts, grabbed the cuddly things from the shelves (strategically placed just-within-reach), and begged for a bunny to hug. Mothers and fathers checked the label, which read, "made in the USA by FooCo-II," and, in microscopic print: "Nineteen bank loans later, thanks a lot!"

Fathers gave the creature a test squashing, and said things like, "Looks harmless enough."

So Bunnybaby sold out, and FooCo looked like it was going somewhere, when disaster struck a second time.

This time, the case was a bit different: "Lynn Bobbie Ann Jones, three, of Waldo, Connecticut, was diagnosed with acute cross-eyes on 10/10/97. After a prolonged search for environmental causes, a most likely cause was found. The bunny-nose glue used in Bunnybaby toys apparently reacts violently with the acid-drool of iron-deficient infants, releasing trace amounts of quaylene, an alkaloid long suspected of causing eye trauma and public relations disorders."

FooCo's defense: "Our investigators have found a much stronger causative agent for the unfortunate disfigurement of little Lynn Jones. As anyone can verify for themselves, there is a hyperwatt transformer outside her bedroom window. There is a 900 gauss low-frequency EMF running through her room. As evidence of its effects, we submit photographs of metal toys stuck to the wall behind the victim's crib. Also, her goldfish were found to be highly polarized, and can only be seen when they are swimming toward the observer. The effect on the girl's sensitive nervous system cannot be overstated."

In the mother's own words: "Little Lynn has always had a difficult time putting down silverware. It seems to leap back into her hands. When she's in the front seat, the compass on the dashboard always says we're going SW. She's a strange kid, but these people peddling their toxic rabbits have got to be stopped."

FooCo lost again.

In 1998, FooCo roasted the Bunnybabies, and released its next creature . . . Bunnybutt. This odd species was noseless, but on the label there was a cute

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poem explaining how it could locate carrots and belly-buttons using its acute telepathic powers.

It sold 222,000 units before all hell broke loose.

The charges: "Jason Weber, age nineteen, claims that his Bunnybutt poked out his eye with its stiff whiskers. . . ."

FooCo observed: "Does the victim deny his membership in the Redlands Fist Gang? Does he also attribute the broken nose, bruises, and knife wound—acquired the same evening—to our client's soft and shapeless product? And, anecdotally, what the hell is this kid doing with a stuffed rabbit anyway?"

This time, employees brought marshmallows and sticks to the Bunny Burning, which was becoming an annual tradition. Donald Wheaton looked like he was about seventy; he had long since pulled out his hair. He still had a sense of humor—though it had its morbid swings from time to time. Indefatigable, he immediately proposed his next creation.

Bunnyblob was a sure-fire thing. It had no whiskers, no nose, and its eyes were drawn on by skilled eyeball artists using only the finest non-toxic crayons. It looked like a blob, thus its name. It came with a tag explaining evolution in layman's terms, and comparing Bunnyblob to the now-extinct narwhal which, through millions of years of careful selection, was just an enormous blob of stuff with no purpose.

Bunnyblob wasn't much of a success, until word got out that it was fun to punch. Then every kid wanted one of the sad-eyed, hopeless creatures to abuse. No matter how much you bopped them and stabbed them, they just squinched back into shape and looked like they were about to cry. They were even safe in the microwave, and when they came out, they bounced like Superballs.

Then, a diapered delinquent set his best friend's Bunnyblob on fire. It sat there in a puddle, and melted like a good bunny, but the kids burned their hands playing with the hot carcass. Their mothers were furious.

This time, Donald actually cried. He called his employees into the office, and watched them slink in and look uncomfortable. These were his friends. He'd been good to the ones who stayed with him, but times were different now. "We're ruined," he said flatly. "People don't want hugs anymore. They want quick bucks, and they'll plow over anybody to get it. Go get jobs where you've got a future. I hear bombs are popular this year."

He could say no more. One by one, the grayed, dejected staff slithered off. The youngest stayed behind. "Does that mean there isn't going to be a Bunny Roast this year?"

Donald almost laughed. "It should be the most insanely popular Bunny Roast ever. Wouldn't want to mess with the tradition. Bring all your friends. . . ."

His last press release summed up his trials and fears succinctly:

"You don't see a whole lot of people suing the companies who make these deranged, exploding war toys,

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do you? I guess that when a kid gets his arms blown off, Dad is expected to think, 'Oh yeah, it's a war toy. It's supposed to do that.'

"So damn the guys who don't do anything wrong. How wonderfully Modern of you.

"Notice the complete absence of control on soap. Soap is dangerous. Several people each year are injured by stepping on soap, but nobody has designed a bar that isn't deadly slippery. I wonder why. I'm sure someone broke their back slipping in the shower, and went to a lawyer, furious. I hope the case got to court, and the judge said, 'Everyone knows soap is slippery. What sort of idiot are you?'

"I'm dreaming. I know. Everyone is liable, but nobody is responsible. I wish I hadn't eaten my thesis."

The release was edited down to a single sentence and packed onto a dead-page in the local paper, between the weekly article on Bridge and a column for xenophobes called "Ask Doctor Goaway." At least six people did read the last words of Donald Wheaton, but the only verbal response was from an overweight English professor: "The average thesis is quite high in dietary fiber."

Soft-Toymakers' insurance became too expensive, the industry was too much of a risk. A year later there were no more stuffed toys. A steel company filled the market gap with a thing called a Wire Hug, which was more of a rock than a toy. Kids killed each other (and several parents) by flinging their Hugs around, but the company never got sued.

Thirty years down the road, the children had all grown into psychopaths. When the National Football League introduced the Uzi as standard gear, people realized that something strange had happened. It was not unusual to see the president strangle Democratic congressmen and eat their heads for lunch ("with a mild horseradish sauce," he said in one interview).

A group of pacifists (in light body armor) scoured the city around the burned-out shrine of FooCo, looking for the Fool Who Once Built Bunnies.

They never found him. ■

The early bird gets the worm. Where does that leave the early worm?

—Kelvin Throop III

The early worm gets the bird.

—Hollywood adage

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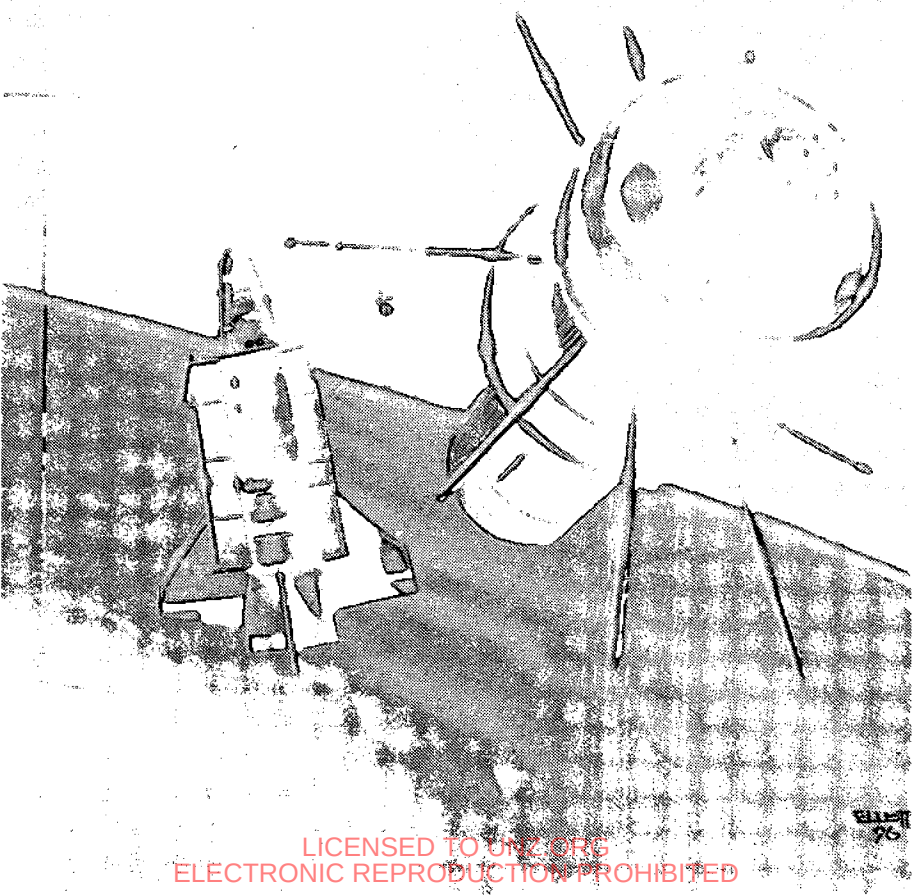
Joseph H. Delaney

BUSINESS AS USUAL, DURING ALTERCATIONS

Just how far might "flight security" have to go?

Illustration by Darryl Elliott



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John Sumpter carefully scraped the last fleck of lather from his face, turned on the tap and rinsed his razor. When it sparkled he risked a glance into the mirror and studied the face he saw there, wondering if someday in the far future it might appear on a stamp or a coin.

He had been president for four whole days now. Not one instant of the time had been peaceful and nothing had happened in that interval to make him think that would ever change. Never an optimist where politics was concerned he had not expected the job to be a bed of roses, but in his wildest dreams he had never imagined things would get this bad.

The day before yesterday the stock market had crashed, plunging a thousand points in a single day. Most of that was recovered in the next session, thanks mostly to intervention by foreign investors looking for bargains, but the part that scared Sumpter was that the dip produced greater losses than the entire equity market had been worth in 1929.

The conditions which had caused this were still operating, of course, and were almost certain to generate more fluctuations. Something had to be done about this right away. That was why the first item on today's agenda was a breakfast meeting with the secretary of the treasury and the chairman of federal reserve board. He wasn't looking forward to that.

Sumpter took a towel and carefully wiped his face, splashed on stinging after-shave lotion, and walked into the bedroom where his wife still slumbered. There he donned the shirt and tie she had selected for him the night before, slid into his jacket and tiptoed out of the room.

When he entered the dining room all conversation abruptly ceased. Coffee cups clinked down into waiting saucers as the others greeted him. He took his seat at the head of the table and an ancient steward whose name he had not yet learned poured a cup of coffee for him.

For a minute or two, while dishes were passed to him and he made his selection there was relative silence, but then, with these chores out of the way, and the waiters having melted back into the woodwork, the working part of the meeting began.

"We'll get a breather on the market situation, Mr. President," Sam Baribeau was saying. The secretary of the treasury was a career man, held over from the last administration because his ideas, while not popular with Sumpter's predecessor, were practical and orthodox. "We're getting good support from the European central banks, and there's a lot of cash moving in from the oil producing countries. These people have to support the dollar to protect what they already have invested. But," he added grimly, "things won't get any better until we do something about the drug deficit."

All the faces at the table dropped at that suggestion. This was the factor that had swept Sumpter's splinter party into power in the first place. The public had finally realized that the dollar drain across the southern border made the trade deficit with Japan look

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puny, and was, in fact, the major reason why every American company with the ability to do so was going multinational.

There were so many expatriate dollars floating around outside the national borders that if they were to suddenly reenter the domestic economy they would create untold havoc. The dollar was stretched to its limits worldwide. It had been forced to cover the economies of countries like Peru and Bolivia, where it had driven the local currencies off the street.

The dollar was being used to do things against the national interests of the United States. Outsiders were gaining control over it, manipulating it. That was a critical part of the problem Baribeau had just broached.

Federal Reserve Board Chairman Walter Holloway's message was just as grim. He lowered his coffee cup and added, "We can't keep interest rates artificially low forever, Mr. President. If they start going up it'll pull a lot of that cash in. Inflation will rise again. The process will feed on itself and pretty soon there won't be anything we can do to stop it. We have to act now."

"What I'd really appreciate from you guys," Sumpter replied glumly, "is some good news. Surely we can do something?"

Baribeau and Holloway looked at one another, then as if by silent agreement, Baribeau became the spokesman. "Basically, we have two alternatives, Mr. President. Both of them are bad. The first one is to repudiate the expatriate dollars outright. The primary effect of that would be the immediate collapse of most of the economies of South and Central America, including Mexico's. There will be substantial ripple effects in other economies, mainly those of the Pacific Rim, because you never can only do one thing. In the worst scenario there might be worldwide depression.

"It's way too late to avoid any of this completely. The best we can do is stretch these effects out some so they'll just produce misery instead of catastrophe. The way we do that is to quietly redesign and reissue the currency. Then we can start an exchange program and we'll be better able to control what comes back in."

"I like that a little better than your first suggestion. How long would this take?"

"We could be ready in a month, Mr. President," Baribeau replied. "We've had the design changes in the works for some time anyhow. For treasury it just means moving up the schedule. Walt would be in a better position to comment than me."

Holloway obliged. "Domestic exchange will be no problem, Mr. President. We can go as soon as we're stocked. There'll be a little more paperwork for the banks, of course, and they'll grumble, but the IRS should have a real picnic."

"It'll be a nasty surprise for the bad guys," Sumpter chuckled.

"Only the small timers, Mr. President. Within hours after you order it every important crook on Earth will know the details of the switch, and that's a conservative estimate."

Sumpter's jaw went slack. The other two gazed at him in frank disbelief

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at his naïveté. He made it worse by asking, "How?"

It was a moment or two before embarrassment forced Baribeau to attempt an answer. Even then, his effort to do it diplomatically was almost ruined. "When it comes to understanding how government works, Mr. President, you're at a disadvantage. Most of our presidents have been lawyers. Those that weren't lawyers were career politicians, or at least experienced in the cut-throat world of big business, big military, or some other well organized discipline. You're the first scientist that ever made it, and scientists don't do very well as herd animals.

"In science, it's the cream that rises to the top. In politics it's the scum. To be a successful politician you have to be good at four things: lying, cheating, stealing, and conniving. Scientists have too much faith in the rules to make really good liars, too much fear of exposure to make good cheaters, too little opportunity to steal to get good at it, and they're too individualistic to be successful at conniving.

"Of the four, conniving with the bureaucrats is the most important, because it's the bureaucrats, not the politicians, who really run things. Nobody elects them, nobody can outlast them, and getting one fired is like pulling the back teeth out of an elephant.

"You asked how they'll know about the switch. They'll know because some bureaucrat will tell them. The bad guys own more crooked bureaucrats than they do crooked politicians, Mr. President. Bureaucrats are a better investment because they're around longer, have more power and don't have to account to anybody." At this point, Baribeau took pity on Sumpter and let up a little. "But we'll still hurt the big boys some, Mr. President."

"Good," Sumpter replied, "because I think we ought to go ahead and issue the new money. If we get the right kind of cooperation from our allies maybe we can at least cripple the drug interests for a while."

Both Baribeau and Holloway nodded in assent. Neither had expected him to turn it down. It was the only reasonable course, and talking it out as they had was only a formality.

"OK," Sumpter continued. "Then go to it."

Two weeks passed. Sumpter, though he knew he would never be comfortable in the role, had nevertheless superficially adapted to the trappings of the presidency. With no substantial formal representation in congress, his administration was more dependent on diplomacy than any that went before it.

He had started out with pretty good relations, although pundits told him that was normal, the so-called "Presidential Honeymoon." It took a while for political factions to size each other up and make adjustments before they began slitting each other's throats.

Subsequent events soon convinced Sumpter his honeymoon would be a short one. He knew his plans to alter the currency were responsible. Congress had been neither consulted nor notified of this. Its consent wasn't re-

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quired. Still, just as he had been warned they would, rumors of what he planned to do began circulating the very day he made the decision and had since proliferated.

He had another breakfast meeting with Baribeau and Holloway to talk about this, and got an explanation that disturbed him.

Sam was a comfortable guy to talk to, very philosophical, very knowledgeable. He was one of those rare people who enjoyed observing cause and effect and who were inordinately good at it. His kind usually gravitated toward scientific pursuits, and this too Sumpter found reassuring.

"You have to understand how things work in the legislature, Mr. President," Baribeau told him. "These guys need big money just to get elected. Some of them spend a hundred times more than their official salaries and allowances will ever gain them. They get this money anyplace they can, any way they can, and society pays the price.

"Greed drives the machine, not ego, like they want people to think. It's a whole lot easier and a lot less risky to get rich in politics than in business. Being in congress, or any public office, for that matter, is like having a license to steal. Everybody does it so they don't dare tell on each other, and because they control the system getting caught rarely means getting punished.

"That, Mr. President, is why your popularity is slipping up on the Hill. The situation down in the border states has been a regular money pump for a whole generation of crooked politicians, especially in Texas, which has the longest stretch of border. They know you're about to try choking that off and they don't like it."

"I don't care whether they like it, can they do anything to stop us from switching?"

"If they could they would have done it before now. No, Mr. President, you're an independent branch of the government, protected by the separation of powers clause in the constitution just like they are. The regulation of the currency is an executive function. They can't interfere." He paused contemplatively.

"But," Baribeau continued, "life will be miserable from now on. Since they can't make you do what they want they'll spend the rest of your term trying to make you wish you had. Your legislative agenda is now just so much scrap paper. Any bill you send them will need absolutely overwhelming public support just to get on the agenda."

There was a moment of silence, then Sumpter asked, "Tell me, Sam, do you think we're doing the right thing?" His tone was grave.

"If I didn't I wouldn't be aboard, Mr. President. Right now this country's on the same road to ruin that Rome took. Getting off is going to be a chore, but in the end our people will benefit more from this than from anything any other president in this century has done. You're our first real populist president, the first one in a long time who has a chance to be a really great one. That's the reason I stayed on with you. Stick to your guns."

* * *

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Sumpter did, but a week later he found out the country was at war.

The declaration came in by e-mail, unsigned, untraceable, through the Internet. In any other administration the White House staff would have tossed it into the circular file and forgotten it. Sumpter's people didn't. Moments after receipt the chief of staff plunked a copy down on his desk.

Sumpter picked it up and read the short message aloud: "Stop the switch, Egghead, or else!"

"I brought it to you because it sounds like a threat, Mr. President. What's it mean—the switch?"

"Leave it, Mary, I'll handle it myself."

"Yes, sir."

"Keep this quiet, Mary. Take personal charge of anything else like this that comes in. Notify me right away."

She nodded, turned, and left.

Sumpter called Baribeau right away. He could have turned the matter over to the Secret Service agent in charge of White House Security but he didn't want anything getting lost in the bureaucratic shuffle. He would keep things on the cabinet level.

Sam already knew. "I was just about to call you, I got one, too," he explained. "Mine has some strange numbers on it, and a time—Greenwich Mean Time—solar time in Greenwich, England, which is where Earth's day officially starts. It says to watch the sky."

"What are the numbers?"

"Thirty-eight-forty N., seventy-seven W."

"Map coordinates, the latitude and longitude of Washington."

"Of course! And the time works out to—let me see—10:35 P.M. Eastern Standard."

"What do you think it means?"

"It's obviously some kind of threat. It could be a crank, looking for excitement, stirring up what he can, or it could be serious. We can't afford to ignore it. I'm going to have to tighten up your security, Mr. President."

There came a knock on Sumpter's office door. An instant later his secretary appeared, waving a piece of paper. Sumpter motioned her to come in, took the note, read it, then dismissed her. "Something else is up, Sam. My press secretary is waiting outside. The note says he needs to see me right away. Stay on the line while I talk to him, OK?"

Sumpter switched to the intercom. "Send Frank Marsh in." He punched another button, and put the phone on speaker.

A moment later the door opened and the press secretary waddled in. He, too, had papers in his hand.

"These came out of my fax just a minute ago, Mr. President."

Sumpter took them, recognized both, then handed them back to Marsh. "Who'd you get these from?"

"Kirby, over at the *Post*. He called me, too, but I didn't take it. I wanted to report first. What's it all about, Mr. President?"

"It appears that we are, as one of my predecessors put it, 'in deep doo-doo,' Frank. Sit down. Baribeau's on the line. Did you get all that, Sam?"

"Every word."

"Obviously, whoever's behind this

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threat is trying to start a panic. What do you suggest we do about it?"

"For the meantime, I think we ought to play dumb. If we go public about the switch we create a media event—just what they want."

"We don't really know anything, anyhow," Marsh added.

Baribeau quickly agreed. "He's right, Mr. President. This is what we should tell the press, that we're taking it seriously but we don't have enough information to make a judgment, and we'd appreciate their forbearance while we try to find out what all this means."

"All right. Frank," he pointed at the door, "Go!"

Marsh was off in a flash, but Baribeau, who could not see this, was confused.

"What was that, Mr. President?"

Sumpter turned off the speaker and answered. "I thought it best that Marsh got back to the *Post* before they went public."

"Good idea. Meanwhile, since the note seems to imply there'll be an aerial display of some kind I'd suggest we include the secretary of defense in any briefing. It's not impossible that some nut's gotten hold of a missile or something."

Those words were chilling. Sumpter hadn't been scared before. Now he was. The thought of a warhead slamming into the White House curdled his blood. Even in the quietest times more than a hundred people worked inside. Some of them were certain to be hurt, maybe killed. "I want the secret service to clear out as many nonessential people as it can."

"We'll take care of that, Mr. President. Everything will be fine. If they mean what they say we've got almost twelve hours to get ready."

"That's assuming," Sumpter answered, "that whatever they're planning happens tonight. It might not. Their note's not dated."

"Somehow, I think it's going to be tonight, Mr. President. The fact that it involves the switch means an early deadline. I think you ought to watch on TV, though, from the bunker."

"I'll think about it. Now, you'd better get to work. Keep in touch, Sam."

"Yes, sir."

The White House bunker was comparatively roomy and quite comfortable. Built during the Cold War to serve as an emergency command post, it was designed to survive anything short of a direct hit by a thermonuclear warhead. It had been kept in a ready condition even after that generation-long crisis had ended, and its communication gear was state-of-the-art. Down here, Sumpter actually had a better view of the sky than he would have had from the rooftop. The best toys the military owned were in operation, including some that easily penetrated the light overcast.

Sumpter actually found himself becoming more relaxed as the appointed time approached. The scientist in him had had most of the day to adjust, to ponder the obstacles an assailant would have in mounting such an attack. He was half convinced that this was a hoax.

But he became even more puzzled

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when, as the onscreen countdown reached zero, a tiny pip of light flared only briefly. In proportion, it looked like a photographer's flashbulb going off. It was far less impressive than the average meteor. It would have gone unnoticed had they not been watching for it.

But a murmur arose from the military people who stood behind him at their instruments, and he knew that he was merely misinterpreting what he had seen.

"What was that?" He asked the nearest of them.

"A chemical explosion, probably TNT, judging by the spectra," the man answered.

"Where?"

"In Low Earth Orbit, directly overhead."

"That doesn't make any sense."

"No, sir. Not yet. But it implies access to far greater technical assets than a simple assassin would have. As a matter of fact, it implies complicity of a major spatial power. The motion of the debris cloud suggests that whatever this was it was, in a polar orbit. That alone takes it out of the amateur class."

"I agree." Sumpter was now far more impressed with his unknown enemy. He was a physicist, not a rocket expert, still, he could now rule out most of countries that had only marginal spatial capability. China, Japan, France, Russia, and possibly India could have done this easily, but none of those countries had a good reason to block the switch, and in fact, should all benefit from the switch.

"Excuse me, sir."

Sumpter looked away from the screen and turned toward the voice. It was Colonel Carl Brinker, his Pentagon liaison.

"Sir, there's been another message. You might want to look at it in your office."

Sumpter rose, and followed Colonel Brinker. Inside his office a sergeant waited with a fax in his hand.

Sumpter took it, read it, and gasped. *"What you have just seen was the explosion of 200 kilograms of TNT. This was only a part of the payload our satellite carried. Unless you immediately cancel all plans to alter the US currency another charge will be detonated. It will be larger. It will scatter hundreds of thousands of steel fragments into near space. These will spread out in a globular configuration to surround the Earth. Collisions would destroy all existing orbiting facilities within a few days, and all near-Earth space will become permanently unusable unless you meet our terms.*

"Our satellite is equipped with defensive devices. If you attack it or attempt to approach it these will activate automatically. You will be given additional instructions in a few days."

The message was unsigned.

"Your orders, Mr. President?"

"Stand by. I'll get back to you. Meanwhile, find out as much as you can about this—but do it safely. Whoever is behind this is right. If we lose the use of near-Earth space we are back in the Stone Age. Tell the guys to be careful, Colonel."

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"Yes, sir."

It had not been a good night for sleeping. Knowing that he might be needed awake and alert on a moment's notice, Sumpter declined the White House physician's offer of a sedative. Consequently, when he finally rose after hours of tossing and turning, Sumpter had slept almost none of this time.

His first act after rising was to contact the duty officer and arrange a briefing. His call was routed to Colonel Brinker.

"Yes, sir. We've made a little progress, although it lengthened our list of suspects. Cheyenne Mountain has located the launch data, of course. It was an ordinary commercial launch, nothing suspicious about it at all, so there was no background check on the customer. NORAD just issued it a pre-launch catalog number as requested, watched it go up and logged it onto the tracking system. That was three days ago."

"Who?"

"Francospatiale, from the Chad facility."

"The French! Wouldn't you know!"

Colonel Brinker didn't comment.

"Have you told State?"

"Yes, sir. They're on the horn with the French foreign minister now. He's promised they'll try to find out who's behind it."

"They're going to try?!"

"Sir, it seems French law is a little vague about stuff like this, and Francospatiale is a private enterprise."

"There's a treaty covering killer satellites, Colonel. Even I know about that. France is a signatory."

"We've reminded them, sir."

"Good. What else do you know about this thing?"

"It's big enough so it could be carrying a large warhead, sir, but I'm afraid we haven't found out much else. We're monitoring it for R/F emissions but so far there haven't been any. Chances are that even if we can intercept transmissions they won't help us identify the people who put it up. Our best chance for that is diplomatic pressure on France. I'm sure they know more than they're telling us."

"Keep on it, Colonel. Report directly to me if you learn anything more."

"Yes, sir." The colonel left, followed by his sergeant.

Sumpter almost wished he had stayed in the bunker with Colonel Brinker, whose unit would remain there for the duration of the emergency. Topside, he had to face the real world, and the real world had become exceedingly ugly.

"It's a nightmare, Mr. President," Marsh grumbled. "The reporters are all over us, demanding interviews. If you turn on your TV that explosion will be on every channel. They show it over and over again. Some of them have enhanced it. Others have added graphics. Every channel's got its 'expert,' shooting his mouth off about how serious this could be. It's a feeding frenzy, welfare for impoverished professors. I'll bet you know at least half of them."

"More like two-thirds, Frank. Scientific controversy brings all kinds of

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people out of the woodwork."

"This is exactly what we don't need, Mr. President, the people are so used to getting their minds washed out by the box that they treat catastrophe like entertainment."

"They may be in for a real shock, Frank. If the satellites go they'll lose a big piece of that. You know, it seems to me that we ought to be taking some polls, getting a sample of public reaction."

"There are some in the works, Mr. President, but no definitive results yet. The only place where an effect really jumps out at you is in the markets. Baribeau and Holloway are having kittens, and I don't blame them. World investment in spatial facilities amounts to trillions of dollars. A threat to that menaces human civilization itself. This is as serious as a nuclear war."

This brought a raised eyebrow from the president.

Marsh felt constrained to elaborate. "It started in the Far East and Europe, naturally, since their exchanges have been open longest. Telecommunications shares dropped dramatically as soon as the markets opened, but the extra business this crisis generated caused a rally and they've stabilized for the time being, although they are lower.

"From there it spread into commodities. Baribeau says these are highly sensitive to climatic conditions, and naturally, if anything happens to inhibit our ability to forecast weather, production will go down. The commodities markets feed on shortage, you see. Now it's beginning to dawn on investors that they could get hurt badly in enterprises that space technology formerly made secure."

"I was afraid of that. That'll cause big problems for countries with marginal economies, and those are the same countries that have caused a lot of our problems with drugs."

"Is there anything you especially want me to watch, Mr. President?"

"Yes, Frank, there is. I want you to watch congress. I know we've got a lot of enemies over there. I suspect some of them are in bed with the bunch who did this. I expect these will be the leaders of an appeasement movement and I don't want defeatism to get a toehold on the public's mind. That could be disastrous."

"I understand. I'll keep on top of it, Mr. President." Marsh turned and walked out of the room.

That left Sumpter alone with his thoughts for a moment. He had learned to cherish such times since taking office. In this job, with all the bright people he had available to advise him, it would have been very easy to surrender to the temptation to let them make the decisions. He resolved that would never happen in his administration.

Sumpter saw the economic consequences as long-term problems. The acute effects would be very transitory if a way were found to eliminate the threat. More immediately vexing were the political implications. Uncle Sam had long been the world's scapegoat, getting blamed for every adversity simply because he was the biggest kid on the block.

He knew it would happen in this

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case too, the superman syndrome would eventually infect the rest of the world. We'll be blamed because they think we can fix it, he thought. They'll resent us if we don't.

Sumpter gave a little shiver. As the nation's leader he should not empathize, but as an individual he could hardly help himself. People envied superior ability or intellect but nobody genuinely loved a superman. The very existence of such superiority relegated all others to inferiority, and the human ego was not very good at handling things like that.

History was full of examples where societies had turned on such individuals for no other reason than that their intellects embarrassed their neighbors. Sumpter often wondered where the world would be today if Socrates had not been murdered, if da Vinci's studies could have been shared instead of kept secret, if Galileo had been allowed to publish what he knew.

The rudeness of the intercom buzzer shattered this brief moment of tranquillity. Sumpter answered, learned the chairman of the joint chiefs of staff was on the line. He pushed the button that was blinking.

Admiral Richard Vogel was a man of few words, and those he used he didn't mince. "It's happened," he announced. "We've got our first revolution out of this and it's right on our doorstep."

"Mexico?!"

"Yes, sir. It's pretty well coordinated too. Three different spots. Guerrero, between Taxco and Acapulco, Baja California Sur, and of course, in Chiapas. All the usual trouble spots, places we've been watching for quite a while. We think this is a mere preliminary, sir. None of these areas is what you could call strategic. They're all a long way from anywhere so this could very well be just a diversion. Logically, the main effort should be a drive up the gulf coast by conventional forces."

Sumpter knew what he meant by "conventional forces." They were a legacy from the last administration, whose chickens were now coming home to roost. His predecessor's saber rattling, intended to intimidate the Castro regime, had alarmed it instead, and it had had better sense than to stay bottled up on an island.

Its response to that increasingly bellicose behavior had been to abandon indefensible Cuba, where it had been relatively harmless, and flee to Southern Mexico, where there was a budding revolution to hijack.

The Cubans had had no difficulty whatsoever in subverting the Mexican military, which would cut its own throat for money, and looked the other way while huge quantities of arms were smuggled in. After that the Mexican government couldn't stop them by itself, and the US military, chilled by its recollection of Viet Nam, opposed intervention.

Until now, maybe, Sumpter thought. Aloud, he asked, "what are the joint chiefs recommending?"

"Caution, Mr. President. We believe it would be a grave mistake to intervene, not only because the current government is sure to fall whatever we might do but because we might need our forces elsewhere, perhaps in the Middle East.

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"But," he hastened to add, "it would be extremely unwise not to close the border. We can do that with organized reserves and National Guard units. Also, we think it might be helpful to show the flag offshore, since there is a carrier task force stationed in the Gulf anyhow."

"Then do it."

"Yes, sir. Sir, may we have a written order?"

Cagey! Sumpter thought, but he's right to cover himself. He's one of the bright ones, and he knows he may be making history. He doesn't want himself, or the country, to wind up on the unpopular side of the war. "It'll come through your fax within the hour, Admiral."

"Thank you, Mr. President. We'll keep you advised."

Sumpter then made a call himself, to the director of the CIA. He wanted a briefing on this revolution. If there was an obvious drug connection he wanted to know about it. If the timing had been mere coincidence he wanted to know that too.

Satellite launches were expensive, and even the drug cartel would have had to strain a little to finance one. Looting the national treasury was second nature to Latin leaders and Castro had left his native country flat broke, so there was a better than even chance he had collaborated and that he had contributed funds. It would be a cheap way to bloody the Yankee nose and punish the United States for frustrating his imperial ambitions.

But the CIA disappointed Sumpter. It didn't agree. It didn't share Sumpter's hunch.

Sumpter's suspicions were aroused. He was keenly aware that spooks were strange creatures, who had strange notions about what was important and what wasn't, and who not infrequently pursued goals of their own. If there was anyplace where treachery and intrigue could be expected it was with the clandestine services. Sumpter did not exclude the possibility that dirty money had turned some of the top people, as it had so many others in government. In the past, the agency was known to have collaborated with drug dealers in Southeast Asia as well as in South America.

The experience drove him to a decision to trust none of the civilian organizations. Sam's sage admonition about bureaucrats and dirty money had been driven home.

The military intelligence people were much more regimented, and therefore more capable of controlling leaks. Nobody was allowed to know more than he had to so a great many more people would have to talk before anything useful to the enemy could get away from them.

Since he was commander-in-chief and the present crisis threatened national security he could eliminate most interference from congress. Admiral Vogel and the chiefs of staff seemed to be more conscious of their constitutional obligations than anybody Sumpter knew in the congress.

There would be accusations of censorship, of course, but the alternative, to let the enemy in on strategic plans, was unthinkable. He would not follow the course that had toppled

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Czarist Russia and made the twentieth century a time of continuous ideological warfare.

As it happened Sumpter was not the only one entertaining such notions. Later on that afternoon he got his first comprehensive report from the State Department. August Powers, his secretary of state, was a capable and conscientious man, but he was not a career diplomat and was somewhat less than thrilled with diplomatic practices.

"They're giving me the runaround, Mr. President," he announced. He sat on the very edge of his chair, pawing through his briefcase for his bundle of correspondence with the French foreign minister. "I'm convinced they know a lot more than they're telling us."

"And just what have they told us so far, Augie?"

Powers had finally extricated the documents he wanted. He glanced furtively through the pack, then replied. "The funds came through Switzerland. No big surprise there." He handed the president a couple of the papers from his stack, then continued.

"Nothing remarkable about the satellite package either. It was supposed to be an ordinary communications rig, assembled by a Russian Company established by former employees of the Soviet space administration. All these people are experts and all are well respected. The French explanation for what was in the package is that while top company leadership was honest they had some employees on the take, and somebody substituted a different payload than the specs showed. They claim all that Francospatiale's people did was mount it on the launch vehicle.

"The instrumentation was mostly Japanese. I've talked to their foreign minister. He confirms what the French say, that it was just business as usual; standard components ordered off the shelf from respectable companies. As far as they could tell there was nothing unusual about the order, not even any custom-made devices. The French think there were other former Soviet people involved in the fabrication of the detonating devices we saw demonstrated."

"What you're telling me is that they don't know any more than we do?"

"No, Mr. President, I'm telling you they're holding back. I don't know why, but I do get the impression that this is highly embarrassing to them and they'd like to get out of it without our help."

"I can understand that. What I don't like to contemplate is unilateral action. This is a global problem. The solution should also be global."

"All the other European governments are cooperating, Mr. President. So are the Chinese, for once."

"I hope that lasts. I expect dissension when we get those 'instructions' the terrorists promised us."

"Me too. But we can't back down, can we?"

"No chance. One alternative is as bad as the other—for everybody, not just us. If they set that thing off we go back to old fashioned technology, which means economic ruin. If we give in to blackmail then the US is no

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longer the superpower, they are. On the other hand we can't let them destroy our economy either, and that's the alternative. Our economy is civilization's engine. Our money is the global standard. If it falls, we fall, and mankind itself falls with us. No, Augie, there has to be another way."

"I hope so, Mr. President. I'll keep at it. So will the rest of your people, you know that?"

"It's because I know that I still have hope. Keep me informed, Augie."

"Yes, sir."

Three days had passed since Sumpter's discussion with the admiral. They had been action filled. Mexico had fragmented. Half a dozen regional revolutions had sprung up while its central government cowered in Mexico City awaiting an onslaught that hadn't come and most thought never would, now that the old regime was doomed. The revolution had decapitated the snake. The body was their prize, so they simply ignored the helpless head, leaving it to rot away. A new capital was being set up in Monterey, long the country's prime industrial and manufacturing center.

The US border was now garrisoned by troops from units drawn largely from the interior, and a strip of land fifty miles wide was under martial law. Military police units, not the corrupt Border Patrol, regulated traffic between the two countries. Civilian authorities, both federal and state, were now powerless.

The flow of drugs overland dwindled from a torrent to a trickle. In Occupied Texas, the Big Bend, through which 70 percent of everything America snorted, smoked, or shot up had once come in, political dissidents who had for years on end been second class citizens in their own country were turning over tons of information to the military. A few local politicians resigned. So did several US district judges and half a dozen federal prosecutors. But most just fled. It was like a horde of cockroaches running from the light.

Sumpter was beginning to feel very good about this part of it. The crisis had not only brought the country together on the issue, it had provided a legitimate excuse to take long overdue action. "If this is all I accomplish in my presidency," he remarked to Baribeau, "I will have justified my own existence."

Then the dam broke. The "instructions" arrived, again by an ordinary fax. Again, distribution had been wide, obviously so that terror would more easily spread. It demanded first, that all the new currency and all the plates for making it be publicly destroyed, and second, that the US Treasury redeem for gold, without question and upon demand, all expatriate money brought into the country.

President Sumpter took one look at the fax and said, "No." He didn't even bother to hold a press conference. Instead, Marsh issued a press release in which he quoted the president's response—"Given the choice of death on our feet or life on our knees, this country will fight."

The general public took it much better than the moneyed interests did. While the man on the street was

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aware that bad things would happen to him if the bomb went off he understood these same things would happen if it didn't. Either way he lost, so he wanted the bad guys to lose right along with him.

The bankers and industrialists saw things quite differently. A howl went up from them, that congress joined in, and which was reinforced by similar groups in other countries. All the people who stood to lose big, and soon, were opting for appeasement.

Congress went into emergency session to consider impeaching Sumpter. But congress, designed as a deliberative body, deliberated. It could not agree with itself, thus the procedure began to drag out. Congressional leaders carefully leaked their not so subtle hints to the media, suggesting that but for their efforts to reach a "fair and just resolution of the differences," the button would already have been pushed.

Sumpter and his allies had a different theory to explain this forbearance. "Threats are ineffective when the victim has nothing to lose. We haven't. We can't fall off the floor."

The man on the street agreed. So, apparently, did the bombers. The situation languished in stalemate. Nobody blinked, but nobody moved either.

The trouble with stalemates was that none ever had or ever could last forever.

Within Sumpter's cabinet the voice of caution struggled with the voice of action. "In the long run this posture is dangerous in itself, Mr. President," Sam admonished. "Uncertainty is debilitating to business. As long as that thing is up there nobody will invest in anything that loss of spatial capability might affect. The enemy can win a long war, and we can't."

He turned his gaze to the other cabinet members at the meeting, noted the nodding heads and added, "we've got to eliminate the threat once and for all, otherwise depression is inevitable and imminent. As Augie is here to tell you, Mr. President, there are plans underway to upstage us." He turned to the secretary of state.

The secretary made his grim announcement. "Our military attaché in Paris forwarded a note, delivered to him this morning. Officially, the purpose is to warn us of pending military action so that we can take steps to protect our interests. It refers to us as a friendly power, but I get the impression that they mean 'friendly' in the same sense that de Gaulle regarded us as friendly."

He gestured toward the admiral, who had been invited to sit in even though he wasn't a member of the cabinet. "I've already furnished a copy to the joint chiefs, who reached the same conclusion I did, namely, that the French are planning to try it alone, perhaps to save face. After all, they did put that thing up there. Admiral?"

"They'll botch it, Mr. President." Vogel's tone was grave. "They've got the right idea but the job's too big for them. They haven't got a system good enough to close in on that thing and destroy it before somebody on the ground can press the button. It may be that nobody has. Certainly we haven't been able to come up with anything foolproof.

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"That's without considering what its automatic defenses might do. We don't know anything about these systems. We don't know what they do, how sensitive they are, what ranges they've been set for or anything else about them. We can't even be sure they exist. They might not. The terrorists could be bluffing.

"We can't determine that without approaching it and risking setting it off. On the other hand my experts tell me that even if neither we nor the terrorists do anything, sooner or later some stray piece of space junk or a meteor will wander into range. There's just no way to get near it without setting it off."

Sumpter had been listening with only half an ear, groping through his memories for a way to do exactly that. He felt something, but so far it had managed to stay just beyond the edge of his perception. It was a rare moment these days when anything from his scientific past was able to dislodge the vicious realities of geopolitics.

Then, in a flash, he had it, snared in a net of logic. He reeled it in, then beamed, "There is a way, Admiral. It's a way we already know will work because we did it once before, by accident." He gazed out at all the puzzled faces. "I guess I'd better explain. You see, all of us were kids then, and some of us hadn't even been born yet, but there was this experiment, a nuclear weapons test, and it all went wrong. This is what happened. . . ."

Donald Grimm, pilot of the shuttle *Endeavor,* and mission commander, was not an easy man to rattle, but he was realist enough to acknowledge that looking up through the hole in the donut could not be very healthy.

Just hours before *Endeavor* had launched, a French missile had come up from Chad. It waited in a parking orbit until they reached their position, then ground control began maneuvering it to catch up to the target, the so-called bucket of buckshot Francospatiale had unwittingly launched for the terrorists. It carried a nuclear warhead, to be exploded in the proximity of this target. Theoretically, the electromagnetic pulse would fry any unprotected electronic equipment.

What worried Grimm was what else it might fry. He knew that even with the Earth between the ship and the device at the time of detonation the residual radiation level would be very high and their next orbit would take them through the debris of the blast. He wasn't very comfortable with the prospect.

True, the explosion would assume a different configuration and appearance up here, since the mushroom cloud was typical only of surface detonations, and the particles would disperse faster without an atmosphere to affect them, but the mission was dangerous nonetheless. *Endeavor* would be pretty hot when she landed.

As soon as he had reported in, the countdown on the ground had begun. Zero was the last word he expected to hear from the ground. When the device went off it would black out all electronic communication, both in orbit and on the surface.

That meant Grimm would have to fly the mission manually from then

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on, and that contact with Earth would be tenuous, slow and cumbersome through their single, shielded laser.

"Zero!"

In response, Grimm burned the main engine for what seemed an eternity, and *Endeavor* climbed steadily toward the bucket. Inside the shuttle four American crewmen and three French astronauts waited pensively for the target to appear over the horizon. They made the first pass through the debris cloud. It was not visible, of course. Their only indication that a thermonuclear explosion had occurred was a prickling sensation on the skin as they passed over the south pole. It felt weird.

"There's the target," Thomas Westwater announced. With radar unusable, *Endeavor*'s co-pilot/astrogator had been searching for the target with a binocular telescope. "I have it in the cross hairs. Our approach looks good but it's a little slow. Why don't you give it a couple of squirts?"

Grimm responded with a two second burn of the main engine and waited. This was when he first started to feel really scared. No matter how much confidence the people on the ground had in the theory, this was still the acid test and nobody knew for sure the theory could pass it.

Just about everything the US had put up here was designed to deal with EMP, and had automatically resetting circuit breaking devices. Russian equipment also had them, which meant that as the pulse weakened, what was dormant in the target now might revive and zap them.

Their safety depended on getting the job done before that happened, always presuming, of course, that the terrorists had bought the deluxe package. If they hadn't, their circuitry would have been ruined by the immense current the pulse induced and put out of commission for good.

As *Endeavor* approached nearer and nearer without incident Grimm opened the cargo door. The EVA crew gathered at the airlock, ready to go out and attach the booster she carried in her cargo bay. Grimm didn't know whether the shuttle could survive long enough to get away if the satellite exploded but he was sure suited men wouldn't.

Westwater dismounted the big glasses and stood down. The target was now near enough to be tracked with the naked eye.

Grimm fired short bursts from the forward thrusters, settling onto station in a manner not much different from routine docking. When relative motion reached zero the Frenchmen went out the lock, while the arm was deployed by the other two Americans inside. From the arm a rocket dangled, its nozzle pointing at the ship, its four spiderlike arms now extended and protruding from its flat nose.

The target floated menacingly near, no more than 50 meters away. Grimm could see there was already a booster mounted behind the payload. They hadn't known about that, since there had been no close reconnaissance. He wondered how the EVA team would handle that. Watching the activity out the port made Grimm very nervous. He knew the pulse had done its job. What scared him was that the effect

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could vanish any time and the target's breakers, if it had any, might reset.

The EVA team wasted no time. Two orange-suited bodies drifted off toward the target, each dragging a nylon rope whose other end was attached to the booster. This would be an old-fashioned operation, nothing fancy, just hectic.

Arm over arm they hauled the booster into position, having been joined by the third man as soon as his duties at the arm permitted him to leave it. A slight tumbling began when the two masses touched but nothing vigorous enough to interfere with the task of fastening them together.

The French team went about its work with practiced precision. Though they lacked actual experience in free-fall before this mission, they seemed to be doing very well. After much tugging the ponderous masses were joined, and the new booster's four arms gripped the warhead firmly. The EVA team then pondered the removal of the target's original booster.

After the first few minutes of this Grimm began to sweat nervously. He had good reason. Nobody knew how long the pulse would continue to immobilize the target's sensors. For all they knew it could fail anytime and the thing would go off in spite of all their efforts.

Finally, he fired a steering jet for a millisecond just to get the EVA crew's attention, then motioned for them to come aboard.

This was acknowledged by a prearranged gesture. The men outside had evidently concluded the extra booster could not be easily removed. They used the booster's attitude jets to manually align the mass, then set the timer and boarded.

Grimm decided against moving *Endeavor*. Though the risk of collision was minimal he hesitated to take it. He thought it was better to stay put while the satellite's booster fired.

The rest of the operation was flawless. The bucket's new engine burned for a full two minutes, killing its forward motion rapidly, driving it lower and lower. The side benefits of Grimm's decision not to move became apparent. By staying put they were in position to see the show. Grimm watched with great satisfaction while the bomb turned cherry red from friction with the atmosphere. A spectacular but silent explosion followed when the remaining propellant and the bucket's charge detonated in unison.

Grimm donned his helmet against the possibility that collision with stray slugs would decompress *Endeavor*. He didn't know whether any of these would reach their orbit, which was fairly high, but he could see others enter the atmosphere, rise to incandescence, and finally traverse thousands of kilometers while they burned to dust.

Grimm was not the only spectator.

In the darkened capital it was 0600 hours, Greenwich Mean Time. Sumpter stood alone on the roof of the White House, gazing up at the sky, watching the most extravagant fireworks display human eyes had ever seen. Although mission control supposedly had contact with the shut-

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tle they had not been able to tell him very much about what *Endeavor* was doing. This visual feast was Sumpter's first confirmation his solution had worked.

There had been a price. Briefly, nothing electromagnetic worked. Powerplants shut down. Radio and telephone communication ceased. Even automobile engines could not be started, the flux was that intense. That would pass, but immense masses of electromagnetically stored data would have been obliterated.

On Earth's surface most of these effects were very brief, except for the communication interruption. In space, fortunately, it had lasted longer. In hours the Earth's own magnetic field would disperse the pulse, just as it had the first time man had done this some forty years before.

Back then it had been a catastrophe, sobering to the extent that both the US and the Soviet Union had spent billions trying to find out how to shield from it. Neither had been willing to risk a communications blackout while the other side's nuclear bombers might be sneaking up.

It was ironic, Sumpter thought, that what once threatened to obliterate civilization had now saved it. He knew that it was time to get on with his own mission.

All the gloom was gone. The immediate crisis was over. Casualties had been very light. Less than a thousand people had been unlucky enough to be in situations where the blackout was lethal. Most of those had brought disaster on themselves by ignoring warnings issued before the blast.

For Sumpter and most of the world, all this morning's news was good, and the breakfast conference at the White House was as much a celebration of what had been accomplished as it was a working meeting.

"The Swiss were stubborn, at first," Powers said with a chuckle, "but with them business is business and the thought of some doper screwing it all up for good scared the pants off them. Their ambassador admitted to me that while the system was down they lost hundreds of millions of francs just in unearned interest. That clinched it. After that they coughed up their records. Then we knew who the terrorists were, where they were and how to nail them. Now, to the dopers, we're the terrorists!" The chuckle became a roar.

It infected Sumpter, who grinned from ear to ear. He had known all along that none of what happened in the international drug trade occurred without the complicity of the corrupt regimes in the producing countries, Baribeau had explained how all that worked. Now, with the rest of the world fully appreciative of the consequences of letting this go on, something had finally been done about it. These regimes would quickly be toppled by concerted and determined international pressure, after which teams of experienced and determined reformers would move in to reconstruct their ruined economies.

With the kind of incentive the world now had to do it nationalistic interests would be forced to yield to collective action. The public would

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demand it. Ordinary people everywhere had suddenly realized that organized international crime had taken the place of world war, that it was a worldwide menace, and that the greatest crime of all was political corruption. People who had formerly been apathetic about it now clearly saw how intimately this touched their lives.

"Yes, sir, it's a brand new world out there," Baribeau remarked, "a turning point in human civilization."

Sumpter did not truly appreciate how literally true that statement was until the meeting broke up and he and Baribeau settled in to a private conversation in Sumpter's office. Of late he had discovered that this guy was more than just a member of his cabinet, he had become a friend, a mentor, a confidant.

"We've got the people behind us now, Sam," he said with a new confidence.

"Yes, we have, Mr. President. That's true, maybe for the first time since Washington's day. But that could be a bad thing as well as a good one. It's also the reason why you might want to consider quitting after one term."

"What?! How can I do that, with all the work that's left to do? Why would I want to?"

"Because maybe it'd be good for public morale, and maybe it would help preserve your place in history."

Sumpter was now staring in disbelief at Baribeau.

"You can't top what you just did, Mr. President. From now on your stock can go only one way, down. Nothing else I can think of would be worse for this country—or the world, for that matter. You're a crisis leader, Mr. President, you're a fixer. The trouble is that except when society faces mortal peril competent people like you are pariahs nobody wants to have around." He paused, watching the words penetrate, like so many daggers, into a man who called him "friend."

Baribeau was agonized by this, nevertheless he knew he could not stop now. "I can see you don't understand," he added. "Let me explain. I realized there was something extraordinary about you when we met. I knew instantly that you were one of history's rare and exceptional people who pop up when they're most needed. Like Winston Churchill was, for instance. Nobody else but him could have pulled Britain through the early days of World War II, yet as soon as the voters knew it had been won they turned him out of office. He was such a monumental personage that even this could not detract from his greatness.

"The truth was apparent to his people even if Churchill couldn't see it. He was a war leader. He would have screwed up the peace, he would have become an obstacle to true progress. He had to go."

Baribeau's tone softened. It was clear he felt great sympathy as he uttered his next remark. "You've got to quit before that happens to you. You saved humanity's frontier when it was menaced, saved the Earth from stagnation and slow death. The race needed you for that, but it needs something different now. There are great changes in the works, Mr. President.

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There's talk now of a constitutional amendment to change the function of congress, to give it an executive mission in place of the legislative responsibility it has now and isn't meeting. If it happens there might not even be a president before very long."

"That's impossible, Sam!" The incredulity in Sumpter's voice was stark.

But it wasn't.

Baribeau was a man of imagination. He was not easily impressed by most things but he very definitely was with this, the sight of the immense roofed canyon which men had made into a cavern larger that many terrestrial cities.

The lesser tug of Martian gravity added to the effect by giving an energy far beyond the expectation of his years, and so when the flivver had passed through the airlock and stopped at the operations shack he fairly leapt out to greet his old friend Sumpter, who waited for him there.

"It's been a long time, Sam," Sumpter grinned, gripping Baribeau's hand firmly. "Come on. Let's talk in my office. It's warmer."

Baribeau nodded, then followed Sumpter. He had not noticed the chill through his insulated garments.

Sumpter's office was not fancy, but it was homey, with stacks of papers and shelves of books and more complicated looking electronic equipment than Baribeau could ever remember seeing in one place before.

Sumpter hustled Baribeau into a chair, then, from some obscure nook he pulled a strangely shaped bottle and some glasses. "You'll like this stuff," he said. "The techs make it from fruit they filch from the experimental garden. I warn you, though, take it slow."

Baribeau did, but its ferocious kick caught him by surprise just the same. He had expected wine. This was brandy.

"Vacuum distilled, Sam. But I did warn you." He sipped his own. "You know," he added, "I never did really thank you for what you did. And if you'd left me to follow my own inclinations none of this would be here."

"You don't know that for sure," Baribeau protested.

"Don't I? You were absolutely right, Sam. I kept busy with scientific work, sure, but every chance I got I watched the show you guys put on too. It didn't take me very long to realize that mine was the easy part. I just started the fight. You finished it."

"I see it just the opposite," Baribeau replied. "I see the breakout as the critical phase, absolutely necessary if we were to complete the circle. We had to get the monkey off our back and you were the guy who made that possible. Inside the government you would have been just another politician. Outside, with no personal interest beyond that of an ordinary citizen, the people could trust you. They did, and they followed your advice.

"Without the confidence you displayed in the reform movement even the United States would have reverted, and without reform there the rest of the world would never have followed.

"The world government we have today has been possible since the communication and computer break-

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throughs in the early 1980s but we kept on using our old system out of apathy. We just couldn't picture a government that functioned without the professional liars around to tell us what to do.

"Look how much better off we are because of your example. Science flourishes now as never before, because market forces are demanding access to the new frontier. The fusion engine on the ship that brought me here could have been built in 1990, and would have been if the right people had been in charge, but no, the vested interests and the bureaucrats had to keep monkeying around with chemical rockets."

Baribeau paused and took another sip, this time with far more caution. I could get used to this stuff, he thought. His tongue started to feel fuzzy.

Sumpter noticed. "You don't want to get bombed, Sam, not today. We've got the Centauri Project appropriation to vote on today." He paused to glance at his watch. "Actually," he continued, "most everybody else already has. We could be the swing vote and I think it might be fairly close. We wouldn't want you to flunk the sobriety test and lose it for us."

"Never fear," Baribeau answered. Yet the stark reality hit him—there had been many issues which had won or lost by one vote margins, and one of them had been the decision to establish the Martian Colony.

He began to wonder what would happen if—no—when the day came that an extra-solar colony was founded. How would the new democracy handle a time lag of light-years? Would the old representative system have to be revived?

He hoped not. Size and dispersal had been the great curse, the price mankind paid for "civilization." His first solution had been the monarchy, because one man could operate with greater efficiency and dispatch than the old tribal democracy could. Man endured the evils this produced for most of his civilized existence. Republics were a compromise, but inevitably these public servants perverted the system and too often they became the people's masters.

Now, thanks to scientific progress the people had the whip again. There was no president of the new government. There was no congress either. There were only the people, who used the modern communications system that space technology made possible to propose and vote on legislation. Immensely powerful computers kept track of things, sophisticated programs prevented cheating, and the race at last was on its way to the next frontier.

Baribeau took another quick sip of the brandy, then remarked, "Maybe you'd better log on and let me vote. Then I'll be able to finish this drink. Maybe I'll even have a refill. Uh, there's another piece of legislation up for a vote today. I proposed it. The vote was timed to coincide with my arrival here." Sam was grinning wolfishly as he plunked the bright new coin down in front of Sumpter.

"What a rotten thing to do," Sumpter fairly screamed. "But, I am flattered."

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"You deserved it, you know you do. Ordinarily, you have to be dead but I figured the people would waive it this once. Uh, what's the matter?"

"On the one cent coin? Why not on the one credit piece?"

"Because you're humble, John, that's why. Now go ahead and vote. You think the Centauri issue will be close, try this one. . . ."

Sumpter entered his password and voted "yes." The circle, he realized, had closed again and the species was again at peace with itself. He wondered how long it would last this time. ■

IN TIMES TO COME

Back in June, Ben Bova had a fact article here called "Extraterrestrial Life: A New Era Begins." At that time, after years of being a largely theoretical exercise, the search for life beyond Earth was suddenly experiencing a veritable explosion of new kinds of observational clues, such as direct observations of planets of other stars and the discovery of life in previously unsuspected parts of Earth. To say the explosion has continued would be an understatement. The mere months since Ben's article have produced developments ranging from unexpected properties of those extrasolar planets to the discovery of what just may be actual fossils from Mars. Almost as soon as the article appeared, we began wanting to give you an update, but it hasn't been easy. Every time we thought we had one ready to go, something new turned up that just *had* to be included! Next month we give you "The New Era—Part II," incorporating as much of the new information as we possibly can—while recognizing that by the time you read it there will undoubtedly be still newer developments. But then, after waiting for this as long as we have, how could we complain about *that?*

In addition, of course, we'll have a diverse array of new fiction, including a new "Ethical Stockbroker" story from Hayford Peirce, with perhaps a more serious theme than you're used to seeing in those tales, but no less fun. Plus the first novelette from Michael Burstein, who won last year's AnLab for Best Short Story with his very first, "TeleAbsence" (which was also a Hugo finalist and got Michael on the ballot for the John W. Campbell Award for Best New Writer); and our first new stories in far too long by Timothy Zahn and Katherine MacLean.

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Stephen L. Burns

THE WAIT

Scientific and technological advances offer lots of new choices—of which one of the most important is one of the least obvious.

Illustration by Janet Aulisio

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The copy of *People* magazine on Alicia's lap was standard waiting room fare, dog-eared and four months out of date. It had been open to the same place for several minutes, far longer than it would take anyone to read the single simply-worded paragraph captioning the two-page photo spread.

"Is this your first time, dear?"

Alicia blinked, then looked uncertainly at the woman sitting next to her. "Excuse me?"

The woman was what some of her friends would call a foxy granny. A trim and well-maintained late fifties, maybe even older, with long moonlight gray hair cascading over her shoulders. She was casually dressed in jeans, sandals, and a loose forest green silk blouse. Her long fingers worked a crochet hook with almost mechanical precision, pulling fine blue cotton thread from a bag at her feet and turning it into tightly woven fabric.

She smiled, revealing a lifetime's worth of laugh lines around her eyes. "I asked if this was your first time."

Alicia tried to make herself get with the program, and managed to produce an unconvincing smile. "Uh huh. First time."

"I thought so. You've already been in for the amnio?"

Her smile thinned. "Yeah, and boy wasn't it fun?"

"And now you're waiting."

"That's right," Alicia agreed in a leaden tone. "I'm waiting."

She didn't really want to be there. Wouldn't have been, either, except that she didn't have much choice in the matter. Jacob Isaac Goldman, the owner of, creative force behind, and absolute authority over Goldman Architectural Design Associates had come down to her workroom bearing two fresh hot Kona coffees—her favorite kind. He'd made himself at home by sitting on one of her workbenches, and given her coffee and hearty congratulations on what he referred to as the "blessed event."

J.I. was what she and everyone at GADA called him, and he was a terrific boss. Alicia was the firm's Chief Nerd. That was even what he'd had painted on her door in real gold leaf after she'd called herself that one time. Her job was to keep GADA's multitude of computers running at peak efficiency, printers and plotters grinding out the paper, net connections stable, and to manage software installation and upgrades. A penny-pinching, elbow-jogging, computer-hating neoluddite like her previous boss could make a task like that an absolute misery.

J.I. made it the best job she'd ever had. GADA was a great place to work. Nice people, the hottest new equipment, one hell of a dental plan. The bennies were grade A all the way.

Except that one had strings attached.

"It used to take several weeks," the woman said. "The waiting, I mean. Before that, this stuff wasn't even possible."

"Progress marches on, I guess," Alicia replied glumly. Sometimes it marched right over top of you.

"So you're what, almost into your second trimester?"

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Alicia frowned down at her squarish, fireplug body. "I didn't think it showed."

The woman laughed. "I had three, and I'm here with my daughter Penny, who's on her third. That's helped make me pretty good at reading the signs that say 'baby on board.'" She lowered her voice as if confiding a secret. "Besides, you're being here gives me a pretty fair idea of how far along you are."

"Yeah, I guess it would." Alicia glanced at her watch once again. Fifteen or so minutes to go. The waiting was getting to her, but she wasn't ready to deal with what would happen when it ended.

"You seem kind of nervous. You shouldn't be. There's really nothing to worry about."

That was just how J.I. had put it. GADA's health plan would pick up the tab for everything. After the baby was born she could take extended maternity leave. Or, he hoped since she was so darn indispensable, come back part or full time for a substantial pay premium. Come back with the baby in tow, of course. Bassinets were nothing new in the GADA offices, and she would also have free use of the first class daycare center right there in the building. Any help she needed managing both a job and a baby, all she had to do was ask.

GADA was a small enough firm for everyone to have a pretty clear understanding of her situation, the boss included. This was his gentle way of acknowledging her single parent status, and letting her know he would do everything he could to accommodate it.

There was, he repeated, nothing to worry about. She hadn't been worried.

Then.

"I'm not worried," Alicia said, trying to sound more confident than she felt. "Just nervous."

"There's nothing to it. Even if a problem is found in the genescan, the therapy isn't that much different than another amniocentesis."

"I know."

"Is there a . . ." The woman hesitated a moment, even her crochet hook halting mid-stitch. "Is there a special problem you think they might find?"

Before Alicia could answer that, the woman continued on in a rush. "I'm not trying to be nosy, it's just that I've seen what they can do. In my daughter Penny's case they're checking for Tourette's and Down's. Penny is fine, and so is her older brother Jimmy, but her younger brother Ricky has to live in a group home. The Tourette's is on Hal's side. Hal's her husband, and has a very mild case that's being treated with medication. Penny's first; Olivia, was normal. Her second, Donny, tested positive for Down's, had in-utero gene therapy, and came out just fine."

"I'm glad." Alicia shook her head. "No, nothing like that—at least that I know of. The only reason I'm here is because it's a rule where I work."

They had just about finished up the Konas when J.I. had sighed, his smile fading. He looked Alicia in the eye, his expression turning somber. "You've maybe heard that I have a son who is

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institutionalized," he said in a soft, toneless voice.

"I guess I might have," she admitted evasively.

"Well, it's true. He was Mandy and my second child, and his name is Leonard. We call him Lenny, but his name should really be Lesch-Nyhan Syndrome. That's the name of the disease he has, and pretty much what he is. First, he's severely mentally retarded."

Alicia waited while J.I. paused for a sip of coffee, knowing from his face and posture that there was more to come. Worse.

J.I. shrugged. "That wouldn't be so bad; he could have a life with that. But with LNS that's the least of his troubles. He's in such constant physical pain that five times a day they have to give him injections of enough painkiller to knock down an elephant. Even still, he hurts."

"I'm sorry," Alicia said, feeling the raw but tightly controlled pain radiating from him while he told this.

"God should be sorry." His shoulders slumped and he regarded her with haunted eyes. "Ah, I don't mean that. But there's worse yet. Because of the LNS he suffers from an extreme form of something called *autophagia.* What that means is he bites and chews on himself. Unless he's restrained he gnaws on his own arms and fingers like a dog with a bone, would take them right down to the bone if we let him. He has to wear a plastic thing in his mouth, not only to keep him from doing that, but also to stop him from biting his own lips off."

Alicia could only stare back at him, unable to imagine living with such a terrible thing, and being able to tell about it so calmly.

"He probably won't live much longer, and God willing, he won't. Eight years of pure unadulterated hell his life has been. Eight years of dumb drugged whimpering misery."

She opened her mouth to say something, anything, then closed it. What could she say?

J.I. flashed her a weary smile. "I didn't come down here to visit and tell you all this to make you feel bad, or to scare you. I tell it so you'll understand a rule I have, one that applies to you now. See, what caused Lenny's condition was a mutation in a single X chromosome. The one bad rivet which made the temple of his body an uninhabitable ruin. Mandy and I had no idea that such a terrible thing could happen to a child of ours, that our love could create such tragedy. Our first child, our daughter Hannah, was just fine."

He drained his coffee cup. "It's the shouldadones that keep you awake at night, Alicia. We could have had a genescan done on Lenny before he was born, and they probably would have spotted that bad gene. The gene replacement therapy available back then was maybe good enough to have fixed the problem, and if not, preventing his birth would have been a mercy. It was an inconvenient, expensive option, and we never took it. Like now I wouldn't spend every cent I have to make Lenny right. Anyway, for our third, Benjamin, you can believe we had it done."

He put his cup aside, a sad but de-

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termined look on his face. "So this is why I ask that you go for the tests we never had done for Lenny. If there is a problem with the child you carry, it can be found and fixed before another life is ruined. Not doing everything I can to prevent another Lenny would kill me. Such work is still expensive, but GADA will pick up the tab. You can make the appointment for during work hours, even go in the company limo if you want."

Alicia swallowed hard. "You said *ask*, but I don't think you're really asking."

J.I. nodded soberly. "I'm not. All this was covered by a clause in the contract you signed when I hired you. I do not like forcing anyone to do anything against their will, but because of my Lenny I can give no leeway in this. I'm sorry, but this is a matter of conscience for me. Do you understand?"

She nodded slowly. "I guess I do."

"Will you make me happy and do this for me? For your baby?"

Right then it didn't seem like such a big deal. "Sure. Why not?"

J.I. hugged her, so relieved he cried. Even apart from needing the job and the money, not to mention the bennies, how could she have said no to a man and an argument like that?

"So what do you do for a living?" the woman asked, her crochet hook going back into high gear once more.

"I take care of the computer equipment at Goldman Architectural."

Her green eyes widened. "Hey, they're really famous! I've been to that museum they designed over Thirteenth. Modern art doesn't do much for me, but I keep going back because that building is one of the most beautiful things I have ever seen. Do you like working there?"

"Yeah, I do."

"That's nice. What about the father?"

Alicia frowned. "What about him?"

"What's he do for a living?"

"He—" She hesitated, not wanting to get into all of that with a perfect stranger. "He's a mailman."

The woman must have picked up something from her tone of voice. She stopped crocheting, cocked her head and said, "You make it sound like he's out of the picture. Are you all by yourself in this?"

Alicia grimaced. "I guess you could say that."

Dave was going to be out of the picture for some time. He was a hospitalized mailman with a fractured skull, three broken ribs, ruptured spleen, bruised kidneys, and both arms and one leg in a cast. The Davey Express wouldn't be making any rounds for quite some time to come. Maybe never, considering how badly his leg—not to mention the rest of him—was messed up.

They had never caught the guys who had done it. His was just one out of a couple of dozen cases handled by one overworked detective. If it had happened while he had been on duty that might have been another story. But no, he had just been out walking his dog the evening he had been jumped.

They had killed Zippy, literally stomping the poor dachshund to death, and had damn near done the same thing to Dave. About all the information the

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detective had was that there had been four of them. That had been learned by simply counting the sets of bloody bootprints leading away.

"But the father wasn't really your partner, was he?"

Alicia frowned. "What makes you say that?"

The woman smiled. "*I can tell zese zings,*" she intoned in a hokey accent, then winked, her eyes sparkling with merriment. "An old feminist like me was marching for the rights of gay women before you were even born. I have a gay younger sister, and two gay nephews. Like the old saying goes, some of my best friends are straight. It's not that hard to tell."

Alicia wasn't really that surprised or particularly put off. Being gay wasn't something she tried to hide. And although she didn't flaunt it—or at least she didn't think she did—she knew that a combination of something about the way she looked and some sort of vibe she gave off made it obvious to a lot of people. Not ten minutes into her first interview with J.I. he'd asked if she was in a steady relationship or been, as he had so nicely put it, "between lady friends."

"No," she said in answer to the woman's question. "Dave is just a real good friend who acted as sperm donor." She let out a sad chuckle. "Becka and I used to tease him about being bisexual."

"Becka was your partner?"

"Yeah. Was. We'd been together in a monoger for almost two years. We'd bought a house together. We decided to have kids together. So we did what a lot of gay women do. We got a male friend—Dave—to donate sperm. It was all supposed to be so romantic. We'd be pregnant together, have our babies together, grow old together raising them."

"But something changed all that."

Alicia nodded grimly. "Sure as hell did. I caught, she didn't. Come to find out, she couldn't. Becka went completely off the deep end. She even demanded that I have an abortion, saying that since she couldn't have a baby I was betraying her by having one."

Hardly aware of what she was doing, she cradled her belly protectively. "I refused. She trashed the place and left—and left me holding the mortgage and everything else." She shrugged. "Don't you just hate it when your life turns into something from a trashy soap opera?"

"You'll meet someone else," the woman offered gently.

Alicia snorted. "I always do. My problem is keeping them."

Before Becka had been Donna, and before her Mariel. Each and every one of them had seemed like *The One,* Becka most of all.

Their almost two years together had turned out to be just one more thrilling episode of Alicia's Post-Millennial Lesbian Love Follies. There were times finding someone to love and be loved by was like being in some sort of cruel lottery where you got the prize first, only to have it later taken away when your ticket proved to be yet another loser.

Alone again, her hopes and plans in

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ruins, and now pregnant to boot, she had briefly considered the abortion Becka had demanded.

But she was in her downhill thirties, and that old biological clock was ticking so loudly she almost had to wear earplugs when she looked in the mirror and counted those sags and wrinkles and gray hairs, which made her look more like her own mother than a potential mother with every passing day.

Especially when she frowned.

"What about your family?"

"My dad's been dead over ten years now. When he died my mom took Jesus into her heart as her personal savior, and her version of him doesn't leave any room for my kind."

"She doesn't accept your being gay."

A bitter laugh. "She prays for me when she isn't telling me I'm going to be microwaved in hell for all eternity because I'm an abomination in the eyes of God."

"That must be pretty hard to take."

Alicia shrugged. "We avoid each other. I was closer to my dad. I know he would've gotten off on being a grandfather, that was something he always wanted. I think part of Mom's problem is her trying to deny a bit of latent DC voltage of her own."

"So you're facing this all by yourself."

She shrugged again. "I'm doing OK."

"Having and raising a child all by yourself doesn't frighten you?"

She stared at her hands. Her nails were bitten to the quick. "Maybe a little. But I want this baby. I think I'll make a good mother—I sure as hell intend to try. I have a good job, and my boss is totally supportive. It's just—" She shook her head and spread her hands in a broad, all-inclusive gesture.

"You mean this place? This procedure?"

Alicia sighed. "You got it."

"You really shouldn't be. This is like, well. . . ." A puckish grin appeared. "This is like the burn-in period they put computers through before shipping them. If there is any problem they find it and fix it now, before it leaves the old baby factory."

Alicia chuckled, tickled by that way of looking at it. "*Burn-in.* I like that."

The other woman laughed. "See? Nothing to get upset about."

Alicia's pleasure faded, her smile with it. "I wish it were that simple. I knew this was coming, but I kept myself from thinking about it. Things a couple friends said only made me avoid it all the more. But going through the amnio kind of made it impossible to do that any longer."

She checked her watch. "In just a few minutes the doctor is going to call me in, give me the results of the genescan, and I'm going to have to—to—" She shook her head, her tongue locking up as she tried to say it.

"To what?"

She forced it out in a harsh, hopeless voice. "To decide what to tell the doctor if she tells me the tests turned up the gay gene."

Understanding flashed in the other woman's eyes. She started to say something, stopped herself. Instead she put down her needlework,

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reached out and covered Alicia's clenched hands with her own.

At fourteen she'd thought she would rather die than live with the urges and impulses blossoming inside her rapidly changing body. At fifteen she'd begun trying to forcibly change by dating boys and even letting them have sex with her. It was awful, and repetition only made it worse. Drinking had helped for a while, numbing the disgust with herself, what she was doing, and what she wanted to do instead. But in the end it had led her to spending the night of her seventeenth birthday in the hospital having a quart of cheap tequila pumped out of her stomach.

Then the following summer she had met Carrie, sweetly fallen in love, and been loved back. It was then that she began to repair her heart, and come to terms with her own sexuality.

By the time she was in college she knew exactly what she was, and had grown comfortable with it. Her dad knew, and accepted it and her without reservation. Her mom was another story. She refused to accept it, and after her dad died she veered off into uncompromising righteous rejection.

Even so, the nineties weren't that bad a time to be a gay woman. For a while there it had been almost chic, what with k.d. and Melissa and Martina and other such popular icons. The Millennium came and went with a brief fuss and little change. Most people knew you weren't some sort of perverse monster who preyed on little girls. Most people had gotten past the point where *lesbian* conjured up an image of some man-hating, combat-booted, cigar-chomping, swaggering bull dyke with a flattop and a physique like a pro wrestler, and *gay* didn't automatically kick off a knee-jerk revulsion.

Most.

Alicia gazed off toward the reception area where soon a nurse would appear and call her name. Once again she protectively cradled her belly.

"There's nothing wrong with being gay," she said with a quiet certainty it had taken years to gain.

"Nothing at all," the woman agreed.

"If I hadn't come to terms with myself I probably would have killed myself drinking."

"One of my friends went through something like that himself."

"But what about my baby?" She hung her head, feeling like there was a million pound weight on her back. "I think about how my mom acts, and what it's like to be on the receiving end of her attitude. I think about how great my love life has been."

"You don't have to be gay to have your partner bail out when a baby enters the picture. Women always have gotten left holding the bag, and I guess they always will."

"I know that. Then I think about Dave, the man who helped make this possible. Hell, I don't even mind calling him the father."

"Is he causing problems?"

"Not like that. It's just. . . ."

She sighed, hunching her shoulders. "He's in the hospital right now because he was the victim of a gay

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bashing. Four 'real men' damn near killed him. They did kill his dog, just stomped poor Zippy and kicked him and—" Her voice broke, and the tears she had been holding back finally began to seep through her tightly squeezed lids. He'd looked like a truck had run over him. Maybe it had. A truck named *prejudice,* a monster ten-wheeler loaded to capacity with fear and hate and cruelty, an uncaring unswerving behemoth that would relentlessly flatten anything unfortunate enough to be in its way.

How could she in good conscience leave her child in the path of such a terrible thing as that?

The hands of the woman beside her closed tightly around her own, gentle and reassuring.

"Let me tell you a little story," she said in a kindly tone. "My husband and I started our family in another time. Back in the late sixties, which might as well have been another age. One where a meat-grinder named Vietnam was chewing up young men and spitting them back out either physically and spiritually damaged, or in body bags. We came very close to not having children. How could we, when the draft and the war were what they stood to inherit? But someone passed on to me a bit of wisdom that changed our minds, and I'm glad it did."

Alicia lifted her head to look at the other woman, was given an encouraging smile.

"Vietnam ended. The draft ended. My children grew up and started their families wondering if they could in good conscience bring children into a world where AIDS seemed to be the medical equivalent of Vietnam. But now even that's finally been licked."

Her grip tightened, and although her voice was filled with conviction, her gaze was tranquil. "What I was told and what I have learned to be true is that you can't know what sort of world your children will inherit. Or what kind of world they will make, or what sort of place they will find in it. You just can't."

She patted Alicia's hands. "If the doctor says your child carries the gene for cystic fibrosis or Down's or something like that, have it fixed and be thankful that you live in a world where such a wonderful thing is possible. But unless you think being gay is some sort of disease, leave that be. Tell the doctor you don't need or want to know. If you believe in God, leave that up to him." She grinned. "Or if you're an old pagan like me, leave it up to *Her*. Just because a choice exists, that doesn't mean you have to make it. The basis for your decision could change, and completely invalidate it. For all we know, maybe next week they'll discover that there's a hate gene, a prejudice and intolerance gene, which would mean that your mother and those gay bashers and every one else with the bitter cinder of bigotry in their hearts are the ones who need the gene therapy. Not you. Not your child, if she or he even has it."

Alicia stared at the other woman, almost afraid to breathe for fear it would shatter the feeling of finally seeing a clear path through the barbed wire snarl of doubt and contradiction J.I.'s rule had subjected her to. Before she could unloosen her

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tongue a smiling black nurse appeared at reception and called, "Alicia Montondo?"

The moment of truth had arrived. The wait was over.

"Uh, here," she answered.

The other woman gave her hands a final encouraging squeeze, then let them go. Alicia started to rise, realized that the magazine was still open on her lap.

She gazed down at the photo which had stared back at her before. It showed what many would consider the ideal—and only proper—family: the beaming dad, the adoring mom snugged under his arm, a chubby baby smiling from her lap; the sort of life and future she would never be able to provide for her child. She still hadn't read the caption and learned who they were and why they were pictured, unable to get past what they represented.

She closed the magazine and tossed it onto the table as she stood up. As she began to turn away her eye was caught by the picture on the front cover.

Delores Sanderson, the first gay female Vice-President.

A shiver went through her as she realized that instead could be a possible future for her child. She turned back toward the woman who had sat beside her. "I never did ask you your name."

"Minerva," she answered with a benevolent smile.

Alicia stared. "Like the goddess of wisdom?"

The woman chuckled and shrugged modestly. "Well, my friends call me Minnie and my charge cards are nearly always maxxed out."

Alicia licked her lips, trying to find words for how she felt. "Thanks, Minnie. I—I can't tell you how glad I am I met you."

"Go," she said with a laugh, picking up her needlework. "Go and blessed be both you and your child."

Alicia nodded, then headed toward the waiting nurse, on the way crossing paths with a striking blonde in jeans and a sweatshirt. Already she was thinking of passing on the simple wisdom she'd been given to a pregnant friend who had been avoiding coming to a place such as this, almost certainly for the same reason it had been such an agonizing dilemma for her.

Just as the nurse began leading her toward the doctor's office she stopped and turned for one last look at Minnie.

Her chair was empty. Nor was she anywhere to be seen in the waiting room.

Alicia frowned, then shook her head. She probably had been waiting for that blonde, and now they've gone home, that's all.

Probably.

Alicia laughed and ran to catch up with the nurse, glad she no longer had to wait to begin the process of making the critical decisions about the future of the son or daughter she carried.

Not that she was going to ask that either, but if turned out to be a girl, she already knew what her name would be.

A name for wisdom. ■

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Probability Zero

Jeff Hecht

A LIFE OF ITS OWN

Be careful what you wish for—and how you wish for it!

"Artificial life is the most powerful tool in modern computer modeling," proclaimed Jeremiah Braun-Higgins with a grandiose sweep of both arms. "These small autonomous programs are coded so they can change slightly as they replicate, and that lets them evolve new capabilities in response to their environment." He was about to describe how A-Life could simulate the whole evolution of organic life when he felt a sharp kick under the table.

Jeremiah stopped cold. He had used the E word. Professor Andrew Harrison Harding had warned him to watch his tongue. Senator Bowen, whose office had paid for their study, was a creationist. Fortunately, the senator himself was far too busy to visit the faculty club to receive their report, but he had sent his economic policy aide, Ms. Poole. Her power suit made Jeremiah feel the suit his parents had given him for graduation had "Goodwill" stenciled across the front.

The professor put down his fork and deftly filled the gap. "Let me assure you that I chose Mr. Braun-Higgins because he can provide precisely the right tools to model the comparative response of autonomous individuals in free or restricted markets. This makes it possible to simulate how people respond to different economic boundary conditions. This initial study is only a first approximation, which must be validated by more extensive projects, but it does demonstrate how eliminating the present minimum wage and welfare laws will stimulate economic activity."

Ms. Poole nodded, unsmiling. "Pro-

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fessor Harding, you said on the phone that you had completed the study. The senator and I would like to see it. We already have scheduled a press conference to distribute the report and announce the senator's new bill."

"We had a little printing problem, Ms. Poole," Jeremiah volunteered. Glancing toward the door, he was relieved to see the professor's assistant carrying four copies of the report he had finished writing at 9 A.M. Wondering uneasily if he had remembered to run the spell-checker during the early morning hours, Jeremiah stood to receive four black spiral notebooks. He handed two to Ms. Poole and one to Professor Harding.

They turned first to the executive summary, as Jeremiah turned to his now-cold lunch. The professor looked pleased, as well he should. The summary was a slightly rewritten version of his original proposal. Ms. Poole looked pleased, too; without welfare, the A-Life organisms had taken on a life of their own, creating new economic activity.

Jeremiah hadn't had time to analyze the nature of the new activity. That wasn't his job, anyway. Professor Harding had hired him to write the software and run the model; the economics professor would get a follow-up contract to analyze the results. The model had automatically tabulated all of its own results, one of many details essential to completing the report on time that Jeremiah had not bothered telling anyone about.

The tables were impressive in their bulk. Jeremiah had programmed the model to generate fifty-five of them. The model itself had chosen the major characteristics to list in the detailed breakdowns. They had looked good when he spot-checked them at 5 A.M., even including the final occupations of the A-Life organisms that otherwise would have been on welfare. "Drown 'em with data," was Jeremiah's motto, and he knew he had done a good job as he watched the two flipping through the pages of densely printed tables. He relaxed, sipping coffee, enjoying the faculty club's blueberry pie, and feeling thoroughly grown up. Now that he had impressed the professor, maybe he could get a real job so he wouldn't have to go back to live with his parents in New Jersey.

"This is a remarkable study, Professor Harding," Ms. Poole said, looking up from one of the tables. "The complete abolition of welfare and the minimum wage are rather drastic steps, but you show they would open whole new vistas of economic activity. This large increase in self-employment means that even the hard-core unemployed can become self-reliant. That certainly shows the moral strength of our position."

She looked back down at the pages, a slight wrinkle creasing her brow. "You will have to make some minor format changes for the press release, though. We need graphs instead of all these numbers, plus better labels. I see a large jump in employment in certain categories in the entertainment field, for example, but the table doesn't identify the types of new jobs created."

Professor Harding glanced at his

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copy. "That's just a formatting problem, isn't it, Jeremiah?"

Jeremiah automatically nodded agreement. "The categories didn't fit in the columns, so we list them separately." He flipped open his copy. "What do you want to know?"

Ms. Poole listed a category code. Jeremiah's finger ran down the page, stopping at the code. "Gender worker," he announced.

"Odd," she said. "What about code 43?"

Puzzled himself, Jeremiah moved his finger to the spot. His eyes read the words "Controlled substance supplier," but his mouth didn't work. There had to be a mistake. Had he left something out of the model?

The professor had flipped to the page, and he glowered at Jeremiah when he had to look down to read it. "What?" he exclaimed, his round face blanching.

The model had taken on a life of its own, Jeremiah realized in the numb silence. He must have forgotten some boundary conditions. His mind raced as Ms. Poole flipped to the page and scanned the category codes.

Her eyes gaped and her cheeks colored. "Whores and dope dealers?" she sputtered. "What kind of model is that? We'll have to cancel the press conference." She slammed the notebook shut, stood up, and stalked off.

They hadn't said anything about moral boundary conditions, Jeremiah remembered with the horrible clarity that comes only after the disaster. It was supposed to be a purely economic model. ■

Honey catches more flies than vinegar, if you want to catch flies.

—Kelvin Throop III

Honey catches more flies than vinegar, but you can catch even more with garbage.

—Anon. Systems Analyst

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IT'S ANLAB TIME AGAIN

YOUR BALLOT WILL BE AUTOMATICALLY ENTERED IN OUR DRAWING FOR A FREE ONE-YEAR SUBSCRIPTION!

December is our last issue for 1996, and as usual we're asking you to help us via The Analytical Laboratory. Not only will your votes provide tangible awards for your favorite authors and artist, but your feedback will help guide our selections of what to offer you in the future. Your vote is important!

Look over all your copies of *Analog* dated 1996, or refer to the annual Index which will appear in our January 1997 issue. Pick your *three* favorites in each of the following categories: novella, novelette, short story, science fact article, and cover. If you're not sure about a piece's category, you'll find it listed in the Table of Contents for the issue in which it appeared, as well as in the Index. List your choices in order of preference (your favorite in each category is #1) on the ballot below, and either mail it in or send it e-mail. The ballot is intended to make it easier for you to vote, but if you don't want to cut it out, feel free to copy it.

To be sure your vote counts, please have it reach us by **February 3, 1997.**

Please, only vote once! Thank you very much!

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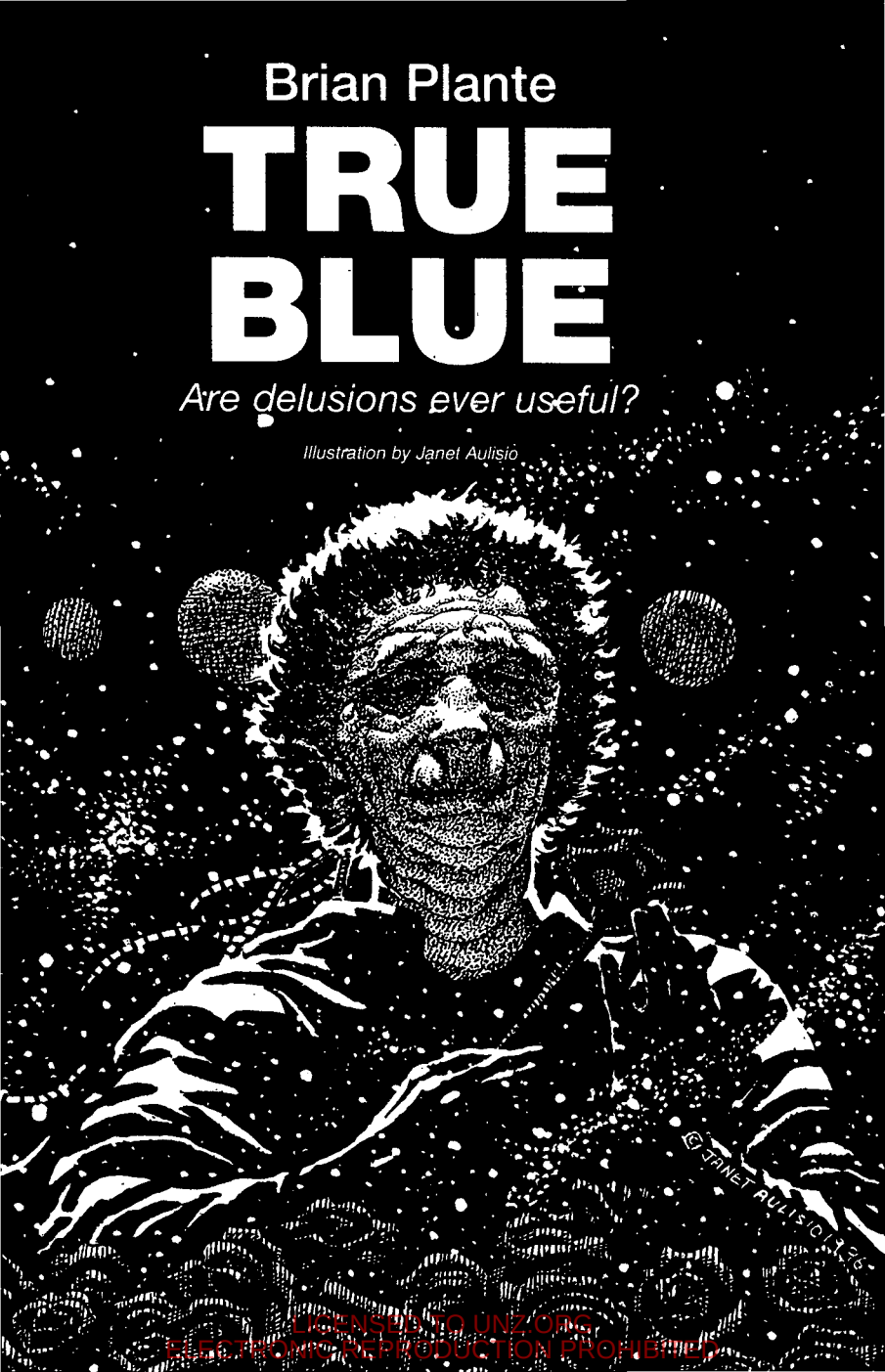
Brian Plante

TRUE BLUE

Are delusions ever useful?

Illustration by Janet Aulisio



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Grandma Ruth stood at the far end of ship's rec room three, her hands fluttering about her, busy at some unseen activity, when Max entered the tiny room. Perhaps she was playing a musical instrument, Max thought. Or sculpting. It was odd watching someone act out their recreational simulation without actually viewing the sim.

"Who's there?" Grandma Ruth asked, looking blindly in Max's direction.

Grandma was a frail, gray-haired woman, seventy-nine years old according to her medical charts; the oldest crew member on board the *John Chapman*, and one of the last of the Earth-borns. Max saw the wire harness trailing behind Grandma Ruth's head, snaking down to the floor and back up to the control panel on the wall. Until he jacked into the console himself, he was not part of her simulation and invisible to her.

"It's me. Dr. Max," he said. Max wasn't really a doctor, having spent his entire life shipboard, light-years from the nearest medical school. The training sims had taught him most of the technical things he needed to know, but he was still picking up the "people" skills, a proper bedside manner, and the time was coming when he would soon take over as the ship's medical officer. Grandma Ruth was old-fashioned and preferred the title "doctor" over "medical officer." Max didn't argue the point.

"Dr. Max," Grandma Ruth repeated. "How nice. Why don't you plug in so I can see you?"

Max thought it would be better if Grandma Ruth unplugged, but it was hard to disagree with the old lady. Like a lot of the crew, Max revered Grandma Ruth. When he was a boy, she used to tell Max and all the kids his age the stories about old Earth. It all seemed so different from life on the ship, the only life his generation ever knew, but somehow Grandma had a knack for making the home planet come alive in the minds of the children where the educational and entertainment sims could not. Max fondly remembered the good times he and his friends had spent at Grandma Ruth's knee listening to the tales of places like New York and Paris and Disney World. Grandma Ruth never had any children of her own, but to Max and couple of dozen others she had been like a second mother.

As all those children grew up into responsible positions, Grandma Ruth had rightfully assumed the position of *grande dame* of the *John Chapman*. Too bad, Max thought, but somehow along the way, the second generation of ship-borns didn't seem to care about the old Earth stories, and Grandma Ruth's audience dwindled. But Max remembered those days fondly, and if Grandma Ruth wanted him in her sim, there was no way he could resist. He picked up a free harness from the console and guided it into the connector on his mastoid bone.

It was a warm and bright one, this simulation, Max thought. He had to squint for a few seconds as his eyes adjusted from the dim rec room lighting to the new perceived level. After he got over the initial disorientation,

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he surveyed the tableau: some sort of flimsy-looking construction, with walls of glass offering dramatic views of blue sky and white puffy clouds. In the structure itself were rows and rows of green plants. Max had never seen one, but had read about such places. It was a greenhouse.

Grandma Ruth had been a cargo specialist in her active years, and on a seed ship like the *John Chapman*, the cargo was mainly botanical, so it almost made sense. But the plants growing in the sim greenhouse weren't exactly the kind of things the crew would be growing when they made planetfall.

Scattered among the green foliage was a riot of colorful flowers, vivid in the bright sunshine. Yellows from the fairest flax to a striking saffron, reds from pale pink to strong scarlet, purples from light lilac to murky maroon. And whites of all varieties, linen and alabaster and milk and snow.

Most rec room simulations weren't this detailed. Max breathed in the heady floral fragrance, so much more clean and natural-smelling than the artificial aromas used in the entertainment sims. It was very impressive.

"They're roses," Grandma Ruth said. "Do you like them?"

It was obvious she had put a lot of hard work into this sim. It wasn't at all patronizing when Max replied, "This is incredible; they're all so beautiful, Grandma. Did you used to grow them back on Earth?"

Grandma Ruth smiled and replied, "Yes, but it was a bit trickier growing them in the dirt than it is in the computer. But then I don't imagine you're here to admire my roses, are you?"

"No, Grandma Ruth. Officer . . . Doctor Lillian said I might find you here. I hope you don't mind."

"Not at all. I like showing off my roses."

"Well, Dr. Lillian wanted me to start making some of her regular rounds from now on. She's going to be retiring from active duty soon."

"She's all right, isn't she?" Grandma Ruth asked.

"Oh sure, but she's getting on in years and it's time to step down now."

"I suppose," Grandma Ruth said, her smile fading as a somber expression came over her face. Against her wishes, she had been forced to give up active duty six years ago. Max had been in training back then, and recalled how Grandma Ruth had fought that decision tooth and nail, but in the end it was Lillian's medical reports that had tipped the scales against her.

"Well, anyway," Max said, "I just wanted to touch base and see how you were doing. See if you needed anything."

"You're just checking to see if I'm still alive," Grandma said through pursed lips. "You don't have to mince words with me. Lillian never does."

"That's not . . . we just want to make sure our Grandma Ruth is all right."

"Who's we?" Grandma said with a silly grin.

"Everyone. Jeez, Grandma, even the little kids are always asking 'How is Grandma Ruth doing?'"

"Ahh, so the death watch has started then, has it?"

"No, that's not what I meant."

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Grandma Ruth put a hand lightly on Max's forearm and said, "It's OK. I'm just being a crotchety old fool. I guess I should be happy that they still send someone out to look after me. And I'm just fine today—thanks for asking."

"I'm glad to hear it," Max said. He gave the greenhouse another appreciative look and added, "Nice place you have here. Is it OK if I come again?"

"It'd be a pleasure, Dr. Max. I'm here every day, same time, rain or shine."

Max made a face. "I know what rain is, Grandma. Was that supposed to be a joke?"

"Actually, no. My sim randomly changes the weather from day to day and season to season. It's supposed to mirror Bloomington, Minnesota." Max gave her a puzzled look, so she added, "On Earth. It's where I grew up. Anyway, I'm always here for the full hour if you want to see me. There's not much else to do on the ship after you retire, you know."

Max didn't know, but he nodded yes as if he understood perfectly well. It was a skill Lillian had taught him, to nod knowingly when a patient described her problems, even if you didn't have a clue what she was talking about. Dr. Lillian had trained Max well and he knew that sometimes a patient needed more than routine medical care. Sometimes a patient just needed somebody talk to.

"Grandma Ruth, what exactly do you do with all these flowers?" Max asked.

"Oh, just a little breeding. Cross-pollination, trying to come up with something new."

"Why don't you just program the simulation for whatever you want, then? It looks like you really know how to program this thing."

Grandma Ruth frowned and made a little tsk sound. "Oh, that'd be no fun at all. The sim is set to vary my results randomly, with the same odds I'd have in real life. You don't cheat at solitaire, do you?"

"Um, sometimes a little. What are you trying to breed?"

"The impossible—a blue rose. They never come in blue, you know. There's a few lavender ones that are pretty close, but never a true blue."

Max thought he saw a hole in her logic. "Then how will your computer let you make a blue one if it's really impossible? If your sim is really playing fair, I mean."

"Well, people have been trying unsuccessfully for ages to do it, but if there's even the slimmest of chances, I think it's worth the attempt. Even if it's only a sim."

Max thought about that. It seemed like a good, healthy thing to have some lofty goal to shoot for, something to keep you going, even if it was only a sim. Perhaps that was why Grandma Ruth had lasted so long.

"Grandma, could I touch one of your roses?" Max asked. "I've only seen flowers in pictures."

Grandma Ruth beamed. "Why of course, Dr. Max. Here, I'll give you one."

Grandma Ruth picked up a pair of pruning shears from the work table and took a few shaky steps back into

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the greenhouse. The rec room really didn't go back that far, but the sim was good enough that it looked like she was moving normally instead of just walking in place. She nipped off a large red specimen, cutting the stem about ten inches below the bloom, and hobbled back over to Max.

"Watch out for the thorns now," she said, handing it to him.

Max was careful to grab the stem on a smooth spot. The thorns looked sharp, and if the tactile sense was as well developed in this sim as the other senses, it could be painful. Tentatively, he stroked the petals and was rewarded with a velvety softness. Raising the bloom to his face he drank in its floral scent. Her sim was vastly more detailed than anything he had ever worked on.

"How long have you been tweaking this sim?" he asked.

"Oh, about twenty years."

Twenty years! Max had never stuck with the same sim for more than a few months. No wonder it was so well developed.

"Are you getting any closer to that blue rose?" he asked.

"Sometimes I think . . . well, not really. It's quite frustrating how chaotic rose breeding can be. You can cross two reds and come up with a yellow. Maybe two seeds in the same pod come out completely different. Even self-pollination produces lots of unexpected varieties. I'm just about to test a new one, if you'd like to watch."

"Oh no, Grandma. I don't have that much time."

"Yes you do. It only takes a few seconds. You don't think I sit and watch the things grow in real time, do you?"

"Um, I can't say I'd given it much thought."

Grandma Ruth worked as she talked, taking a seed tray out of a small refrigerator under the workbench.

"No, I do all the regular work, the bagging and pollination and germination, but once that's done, I just fast forward the sim and get to the results right away."

"Hmmm. Now who's cheating at solitaire?" Max wondered aloud.

"Oh, nonsense," Grandma Ruth insisted. "The computer plays the odds fairly. I just skip all the waiting around. Here, let's see how this one turns out."

With a trowel, Grandma Ruth scooped out a handful of tiny seedlings from the brown germinating material in the refrigerated tray and carefully transplanted each into its own clay pot of dirt on the workbench. Then she put the pots in a sunny spot on the shelf above the bench with some other similar pots and watered the whole lot of them quickly. Max looked up at the transparent roof of the greenhouse and admired the scattered clouds and blue sky of the sim. The wide open view was a lot more impressive that any vista offered in the cramped confines of the seed ship.

"Now, a quick macro," Grandma Ruth said as she reached for the simulator console, which was the only non-sim thing in her imaginary greenhouse. It floated near the back of the workbench. She punched a few keys, and Max noticed a change in the greenhouse illumination. The sun had

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shifted position and the low puffy clouds had been replaced by high, thin ones when Grandma executed her macro.

Looking back down at the workbench, Max saw that most of the pots had sprouted a spindly six or seven-inch plant, and all but one of those sported a tiny bud or two.

"I know they're not very impressive when they're this small," Grandma Ruth said, "but they're usually good enough to judge how the color is going to turn out if I let them grow to full height."

The buds were several shades of pink and lavender. Nothing close to a pure blue.

"Some days are better than others," Grandma Ruth said, emptying each of the pots, one by one, into the large garbage can at the far end of the workbench.

"I still think they're beautiful," Max said.

A smile broadened on Grandma Ruth's face. "You're a good boy, Dr. Max. Come again, won't you?"

"I will," he said, reaching behind his head to unplug the data harness.

As the connection was broken, the red rose in his hand vanished and the room was restored to the cramped cubicle it had always been. Grandma Ruth continued to labor at her invisible workbench, pantomiming her cutting and arranging.

"Bye, Grandma," Max said.

"Bye-bye," she replied, staring blind-eyed in his direction as he slipped out the door.

The next day Max found her hard at work among the roses again. He had gone over her medical records, and didn't like what he had seen: hardening of the arteries, dangerous depletion of bone mass, partial loss of vision. Maybe the early onset of Alzheimer's. No wonder she had been forced to step down from active duty. On paper, she was falling apart.

"I've come to give you a shot today," Max said as he plugged into the sim console.

"You've been talking to Lillian, then. Is it the calcium shot or the blood-thinning one?"

"The blood-thinning one. Jeez, Grandma, your charts don't look very good. Are you feeling OK?"

"For this one hour a day, at least, I feel just fine. Sometimes, when I'm not busy with my roses I don't feel so good. I'm not complaining, mind you. It's supposed to be like this when you get older, I think."

"Well, not if I can help it," he said, administering the injection. "What are you working on today?"

"The same as always. The blue rose."

"Don't you get tired of the same thing? Why don't you just relax a bit and enjoy all the other beautiful roses that you can grow?"

Grandma's smile broadened. Classical conditioned response, Max thought. Compliment Grandma on her roses and she can't help but smile.

"Oh, nonsense," Grandma Ruth said. "If I stop and think about this too much, even that one hour a day when I feel good will become just like the rest of the day."

"How's it going then? I mean with

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the blue rose," Max asked.

"Same as usual. I've got a new batch ready to go," she said, pointing to the row of pots on the shelf above the workbench. "Want to see?"

"Sure. Maybe one of these will be the lucky one."

"Oh, now who's the optimist all of a sudden? Well, here goes."

Grandma reached over to the console and punched in her macro. When Max looked back the other way, the pots were suddenly full of young budding plants.

"Let's see," she said, tossing the resulting plants one by one into the trash as she inspected them. "Too much red . . . white . . . lilac. Say, do you see a hint of blue in this one? My eyesight's not very good anymore, I'm afraid."

The one in question was purplish, but Max thought it was closer to blue that any of the others and he agreed.

"Yes," she said. "This one may be worthwhile. I'll just graft it onto a heartier root system and see how it does in full bloom."

"How long will that take? I can't stay very long."

"A couple of minutes. I have lots of macros."

Max didn't doubt that for a second. Grandma Ruth obviously knew her way around a sim console.

"How many different cross-breedings do you do in a week?" he asked.

"A whole week? Oh my, probably about forty or fifty."

Max did some mental arithmetic. My God, he thought, if she'd been at this for twenty years, she had probably done in the neighborhood of 50,000 crosses without giving up hope.

"Grandma, if you ever succeeded, ever came up with a pure blue one, what would you do? You can't take it out of the simulation."

"Oh, I think I'd just look at it awhile. Then I suppose I could die a happy woman."

Max looked concerned. "That was a joke, I hope?"

"We'll see when I get a blue rose," she said in a voice that gave away nothing.

"In that case, I hope you never succeed."

"Don't want me to be happy, huh?"

"Don't want you to be dead."

"That's sweet, Dr. Max. Here, have another rose."

Max took the proffered flower, and it smelled delightful, but it was gone a few seconds later when Max unplugged.

The following day he had to give her a calcium shot. The shelf above the workbench was filled with pots, many more than he had seen in his previous two visits.

"Trying something new?" he asked.

"That-one you saw yesterday that showed some promise," she replied. "The blue tendency persisted in the adult blooms too, so I'm just doing a lot of self-pollinations, hoping for some variation."

"What, a mutation?"

"Not really. Mutations happen once in a long while, but all pollinations are a toss of the dice with roses. That's why when you finally get one you like, you have to use cuttings, not seeds, to propagate it. The stubborn things hardly ever breed true. It's a

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curse, but it's also why there's so much variety."

"Are those ready to go?" Max asked, pointing to all the pots lined up on the shelf.

"My fourth batch today," she said. "Let's see what happens."

When the macro was run, a wide variety of plants emerged in the pots. Many were bluish purple like their progenitor, but some were different. A few reds and violets here and there. Some bore no flowers at all, and a few had green "flowers" composed entirely of leaves instead of normal petals. But it was one even stranger that caught their attention at the same time.

It only had one bloom on it, and it was misshapen. The petals were too thin instead of broad, giving the bloom a very un-roselike appearance. But it was the color that had attracted their attention. It was still basically a bluish purple, but there were blotches. Blotches of very pale blue.

"Is that good?" Max asked, not sure if spots counted.

"It's certainly different," Grandma responded, squinting at the bloom. "The shape's all wrong, but those patches are encouraging. If I could get a whole rose that color, I suppose you *could* call it blue."

Grandma Ruth had a faraway look about her. Max wasn't sure if she was about to topple and grabbed her wrist. She seemed incredibly frail in his grasp.

"I'm OK," she insisted. "I was just daydreaming."

"Do you think you could do it?" he asked. "Make a blue rose out of this?"

She shrugged. "Who knows? I'd have to do something about those sorry-looking petals in any case. Maybe this one's not worth fixing. Stop by tomorrow and we'll see if I can't make something out of it."

"Well, good luck."

Max stood quietly admiring Grandma Ruth for a few seconds. What if she succeeds? he wondered.

"So," she said, "what are you waiting for? I have a lot of work to do here before my hour's up." Grandma had developed a frown and some deep worry lines had crept across her brow.

"Aren't you going to give me a rose today?" Max asked before exiting the sim.

"Oh, oh, oh. Why sure, Dr. Max," she said, her face brightening as she reached for the pruning shears. "I know how you love them so."

She shuffled unsteadily back to some of the mature bushes deeper in the greenhouse and quickly cut a couple of pink ones.

"These are very beautiful flowers," he said, accepting them from her. A broad smile blossomed into full flower on her face, just what he was looking for.

"Maybe tomorrow I'll have a blue one for you," she said. "You like blue?"

"It's my favorite color," he answered.

When he made his rounds the next day, the whole bench and a large section of the floor was covered with pots, all ready for the macro that would make them grow.

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"Dr. Max! I've been waiting for you." Grandma Ruth said.

"Grandma. You, waiting for me? But why?"

"It's my eyesight. I think . . . well, I just want to make sure I don't miss anything."

"Ahh, then you're getting somewhere?"

"I've run four more crosses since yesterday," Grandma Ruth said. "I mixed the ones with the blotchy spots and a variety that has very broad petals. The earlier batches didn't always bloom, and some of the blooms that did come were pretty weak and slow, but I think I'm finally getting somewhere. The flower shape is almost there, and I've gotten the size of the blotches up too. I think this batch could be the one, Dr. Max."

Max worried that she might be right. Grandma Ruth needed something to work for, something to occupy her time and keep her vital spark alive. If she got her true blue rose, would her enthusiasm for life be diminished?

"Well," Max said, looking nervously around the greenhouse, "you certainly have enough pots here. I'm sure whatever happens will be for the best. Give it a shot."

"Here goes," she said, reaching for the console controls.

Instantly, the pots erupted into a miniature forest of green stalks. Among the stems were occasional dots here and there of spotted blossoms, some showing traces of blue coloring, some not. Many of the buds had not opened fully yet. Looking closer, Max noticed something entirely new among the flowers. There were shiny bronze-colored *somethings,* like little beads scattered among the roses. Max thought the bronze beads were some new mutation, but he heard Grandma gasp.

"What are they?" he asked.

"Beetles," Grandma said in a moaning voice. "Japanese beetles. The simulation throws them in once in a while to keep me honest. This is bad timing."

Max looked closer and saw she was right. The bronze beads were moving, lazily moving up and down the spindly stems. They were happily eating the plants, and had already inflicted a lot of damage. While watching the beetles at work, Max's attention was drawn to a bud that was only just beginning to open at the back of the shelf near the console. It was nearly covered with the beetles, and several spots had been chewed into the side of the bud already. But it wasn't the beetles that had caught Max's attention, it was the fringe of petals just beginning to poke through the top of the bud.

It was blue. True blue. Only a tiny bit of each petal showed above the green leaves of the bud, and the rest of the petal might not be as consistent as the tip, but there wasn't even a trace of the purple color showing. It was, however, quickly being devoured by the beetles and they might never know what the rest of the flower looked like if something wasn't done quickly.

"Look," he said, pointing it out to Grandma.

Max heard Grandma Ruth's breath

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audibly falter as she spotted it. He thought she was going to faint dead away and he moved over to catch her if necessary, but instead she sprang forward, moving quickly over to the blue bud.

"Oh no you don't," she said, her voice rising as she swung a balled fist in the direction of the bud.

Max thought she was going to smash the bud, but her blow landed on the console instead, mashing a pair of hungry beetles into paste. Max was surprised at the force of the blow, not believing gentle Grandma Ruth capable of mustering such anger and energy. Her face registered an expression of horror and desperation.

Grandma fanned at the blue bud with her open hand, frantically shooing the bugs off the damaged flower. Grandma rained blows on the scrambling insects, covering the console and the workbench with virtual bug goo.

Suddenly, the whole universe jittered once, then twice, like an earthquake seen but not felt. Max instinctively put out his arms to steady himself, but the floor wasn't moving. The force of Grandma's blows was taking its toll on more than just the bugs; she was damaging the console.

Grandma Ruth smacked another beetle on the console and suddenly the lighting changed, subtly but surely. It was dimmer, as if a cloud had passed in front of the sun. Max looked up and saw the sun was still unobstructed, but the sky was somehow different. Darker. More angry.

More blue.

And it wasn't just the sky. The clouds were tinged with the lightest azure as well. Looking back around the greenhouse, Max realized everything had shifted ever so slightly toward the shorter wavelengths. Even Grandma Ruth's skin looked pale, drained of its natural healthy pink tone.

She continued pounding the scrambling beetles on the console, until Max took her thin wrists in his hands and made her stop. She was likely to break some bones if she continued.

"I can save it," she said, struggling against his grip. "Let me go. I'll graft it quickly onto a better root system. You'll see."

Max wasn't sure he wanted to see, but she strained to free herself from his grasp and he had to let her go, afraid she's hurt herself with the exertion. Max fished about in his medical pouch for a sedative while Grandma Ruth quickly sheared off the six-inch stalk. In seconds, she had cut and taped the stem onto the branch of a mature bush. Max restrained her when she tried to return to the console, and administered the calming injection.

"No more macros today, OK?" he said. "I think we've had enough excitement for now."

"But I have to know!"

"There's tomorrow."

"It'll only take a second."

"The console's a mess," Max said, looking at all the smashed bugs and a couple of cracked keytops. Even if it was only virtual bug juice, it was disgusting. "Tomorrow," he repeated, plucking the wire from the back of her head.

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* * *

Max insisted on going into the sim with Grandma Ruth at the start of her regular recreation hour the next day. He noticed on entering the sim that the clouds still were tinged faintly with azure. A few seconds later, Grandma Ruth was at the console and ran the macro.

The grafted bush was instantly aged many weeks, and now sported nearly a dozen of the roses. And they were indeed blue. Much darker at the petal tips, but still a pale azure on the rest of the flower. The same azure that painted the clouds, Max noted.

Grandma Ruth squinted, examining the roses, then looked back inquiringly at Max. "Dr. Max, is it . . . I can't tell . . . my eyes. . . ."

Grandma Ruth needed something to keep going. Something like the blue rose, to work on and take her mind off of the problems of aging. She had worked twenty years for this moment, even if it was just a malfunction within a sham simulation. For what? In what should have been her moment of triumph, it wasn't the flower she was looking at with delight. It was Max. What she needed most now wasn't a true blue rose, Max realized, but *him*. His approval. His compliments. His attention. Grandma Ruth craved an audience, even if only an audience of one.

"It's blue, Grandma," Max said. "True blue."

Grandma sighed contentedly.

"It's very beautiful," Max added. "Ahh, and that fragrance. . . ."

Grandma's expression of wonder changed, her mouth stretching to a wide smile. All the while she continued looking at him, not the rose.

"Excuse me," a disembodied voice boomed, startling them both. "I'm here about the problem."

Grandma and Max both looked in the direction of the voice. A few seconds later a form appeared, jacking into the console. It was Jerry, a mechanical engineer and troubleshooter.

"Problem?" asked Grandma.

"Yeah," said Jerry. "Some reports about the chroma balance being off in rec room three."

Max cringed and began talking very fast. "Jerry, you know Grandma. You're just in time to see Grandma's masterpiece. She's been working for twenty years in this sim trying to breed a true blue rose. And here it is."

"Yeah, but I can see everything's just a little. . . ."

"Isn't it beautiful, Jerry?" Max insisted, his eyes commanding the right answer.

"Well, sure. I guess so. How're you feeling these days, Grandma Ruth?"

"I'm doing well, Jerry. Long time no see. Do you really like the flower?"

"Yeah. It's great. Do you want me to come back later?"

Grandma cut one of the blue roses and put it in Jerry's breast pocket.

"Mmmm. Smells real nice," Jerry said.

Grandma's smile broadened even more with Jerry's remark.

"It's a nice color, isn't it?" Max asked.

"Um, yeah, it really is. Well then, if there's no problem, I'll just be going now. See ya."

"Bye-bye, Jerry," Grandma said.

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"You come and visit whenever you want."

Jerry reached behind his neck and disappeared. Max heard the door close with a thump a few seconds later.

"So, Grandma, what are you going to do now?" Max asked. "Sit back and enjoy the roses?"

"Oh, I don't know. This sim is finished for me now, I suppose. Dr. Max, you really like flowers, don't you?"

"More than anything. They make me nostalgic for some place I've never been but have only heard about from a master storyteller."

Grandma Ruth looked lovingly into Max's eyes. Just like a proud mother, he thought.

"I was just thinking," Grandma said, her big smile holding firm. "Did you know, there's some tulips that are supposed to be black, but they're really just a dark purple? I'll bet a true black tulip would be something special. What do you think?"

"That sounds like a fine idea to me," Max replied. Grandma Ruth needed something to keep her going all right, Max thought, but it wasn't the flowers. It was an audience.

"And tulips don't have what you could call a fragrance," she said, lost in her thoughts.

Max laughed. "If you could make them black, or smell sweet, would you let me have one?"

Impossibly, Grandma's smile got even bigger. ■

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Alexis Glynn Latner

THE LIFE-BLOOD OF THE LAND

As Kelvin Throop once observed, a lot of humanity's troubles are caused by fluids going where they're not wanted or not going—or staying—where they're needed. . . .

Illustration by George H. Krauter

Earth had been a greenhouse, wrapped in dirty air that made dawn long and rosy. Not so this planet. Here, in the early morning, the home dome's skylight let Mark see a square piece of pale, cloudless, bluish-green sky.

The new day highlighted the wrinkles on Evrett Reynolds's face and hands. Ev cleared his throat. "Mark, you and your people are doing a good greening job here. But about this wild water chase of yours. Isn't it time to give up?"

"No. It's there, just deeper than we thought." Reckless, Mark added, "I dreamed about it last night."

A pained expression crossed Ev's aged features. "You always were a dreamer."

"So were you!"

"Not anymore," Ev said. "I've got the whole godforsaken ecosphere to think about."

When they left Earth, they had been the same age. Not anymore. Ev had been revived forty years ago, while Mark remained in the cold zone of the Starship, undreaming, unknowing and, for most practical purposes, dead. Ev had thrown himself into the work of the new world and climbed as far up as the ladder went. Ev became the World Director of Ecogenesis. And old. And unfamiliar.

Mark fumbled for a reasonably clean mug, which he filled with water. He put the mug into the microwave oven, antique but sturdy technology that worked well for its intended purpose.

"Rainwater runs off too fast," said Mark, facing the oven instead of the old man who had once been his best friend. "The soil needs to be conditioned so it can hold water. Drygrass and associated microorganisms accomplish that. Lusher vegetation, more organisms, would do it faster. If we can find groundwater, bring it up and fix it in biomass—"

"But you haven't found any."

Mark opened the oven. Hot water vapor emerged, carrying a chemical stench. Behind him, Ev demanded, "What the hell was cooked in there last?"

"Drilling mud. They're trying to adjust the additives for downhole conditions such as heat."

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"Is the mud made with water from your cisterns? Convince me your stinking mud isn't a waste of water."

Mark placed the mug beside the jar of instant coffee on the table in front of Ev. "The geologist thinks water migrated deep into the rocks in ages past and got trapped there."

Stirring the coffee, Ev's spoon rattled in the mug. "She probably just wants to get her hands on a long core sample." He was a tired and decisive old man. It still unsettled Mark that Ev's hair, the little left of it, had turned yellowish white, the remains of what had once been a blond mane.

Mark turned away from Ev to take a fly out of the mesh box in the refrigerator. He lifted the lid of the terrarium on the kitchen counter and dropped in the chilled fly. The golden garden spider in the terrarium waved its forelegs attentively, hungrily. Mark selected another fly. Today, two flies, not just one, for the glorious and hungry spider.

Ev asked, "Pet?"

"Our mascot. What we're trying to do is weave the web of life across the land, strand by strand."

"How deep is your hole in the ground now?"

"A couple of miles. The water will be under pressure." Vividly dreaming in the dim earliest hours of this morning, that was what Mark had seen. "The water will spurt up out of the ground like a geyser and fall on the ground like rain out of a clear sky."

"I can't sell dreams to the Creation Council," Ev retorted. "There are more promising places to drill for water. And a limited supply of drilling equipment."

Thawed out, the flies buzzed in the terrarium, about to blunder into the orb-woven design of their destiny. The sound irritated Mark's already strung-out nerves. He said tersely, "We've hit hard rock. Impermeable enough to trap water underneath. Hard stuff."

"Let me guess. You need another drill bit."

"A bit with diamond teeth," Mark said softly.

"What! Damn your monomania! Mister, I don't play favorites. You have gotten what you asked for, so far, because you've been doing good work out here in the blasted interior. Don't blow it on a pipe dream!"

A sleep-rumpled resident of the dome started to enter the kitchen. Finding the Director of Ecogenesis sitting in there and vehement, he backed out. Mark was sure that interested ears would now be stretched toward the kitchen from the safety of the hallway. Mark felt himself flushing, hot and probably brick red. "Listen. Your job is the toughest in this world. You have to cover land with grass and forests. But where water should be easy to find, it isn't. Or you get too much water too fast, like that hurricane that went inland and ruined the manioc plantations. There've been stupid decisions—mostly not yours—on top of good bets going bad, and the greening isn't going so good."

"Says who?" Ev asked curtly.

"I'm an ecologist. I can read the handwriting on the wall." Mark wasn't going to spell it out aloud—not with

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one of his people listening in the hallway. But he knew the truth.

The ship had been incredibly lucky, finding a planet where life already existed. Evolution here had gone as far as marine microorganisms. The shallow seas were full of plankton that had changed a primeval atmosphere to breathable air comprised of oxygen and nitrogen. All that lacked was to green the land. But that alone was harder than the children of gentle Earth had anticipated. The human and biological resources that the ship had brought from Earth were finite and dwindling. The greening of this world was failing.

"Try a bad bet for once." Mark listened to himself with a strange sense of detachment, as if his words were more real than his body. "Give me a diamond drill bit."

Ev's face contorted. It darkly fascinated Mark, how anger looked so ugly on that aged face.

Slowly, incredibly, the anger resolved into a grin, weirdly familiar, the grin of the bright-eyed kid on the other side of the stars. Ev said, "Hell, Mark, maybe you're right. Maybe I have been hedging my bets too much for too long. Let me think about this. I might just give you what you want."

In the achingly cold gray hour before sunrise, Mark watched an acre of grass burn. Fire spread like a puddle, exploring combustion possibilities in the sparse dry vegetation. Mark held a shovel poised to beat back the edge of the fire if it started moving too fast. Ten others, greeners who worked in his outfit, formed an arc of vigilance downwind from the fire. The heat felt good at this chilly time of day.

Beside Mark, the biologist Chang beat out a forked tongue of flame. "Watch it, boss," Chang said. "If it gets out of control, and we have to call down the fire squad from the Ship, there'll be the devil to pay."

Mark evaluated the extent of the burn. Summer's drought would soon end in fierce storms with lightning falling thicker than rain. The lightning never found the tinder to start a real conflagration, only small fires that puddled ahead of the prevailing wind. The firebreak was now big enough to thwart one like that. If worse came to worse, there were concrete cisterns buried in the ground, water saved from the last time the creek ran wet with storm runoff, with which to damp a wildfire. "Let's put it out." With his shovel, he threw dirt onto the flames. The greeners followed suit. Having smothered the fire, they sifted the ground for embers, mashing those they found to harmless bits of ash.

Somebody shouted, "Zeppelin!"

Like a pink pearl in the dawn-lit sky, the supply zeppelin approached from the distance, floating down toward its pier.

A sweating and sooty Chang materialized at Mark's shoulder. "When he visited us last week, were you able to persuade the director to give you soil polymer?"

"I didn't ask."

Chang frowned. "We need soil polymer in the Canyon."

"No more than other outfits need it for their special places. There's never enough to go around."

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Chang held his tongue, as usual. Mark thought, *What we really need is an artesian well.* Throwing his shovel on the pile with the others, to be cleaned and returned to the tool shed, Mark turned away from Chang and walked toward the zeppelin.

On the zeppelin pier lay a heap of goods fresh out of the cargo bay. Mark's assistant and the zep pilot haggled over minor additions and subtractions to the supply list. But they had already dispatched a high-priority package to the drilling derrick.

Mark wanted to run, but made himself walk so as to appear more calm than he felt. His destination, the derrick, pointed toward a morning sky of ceramic blue. Grass covered the hills beyond it. But the green was fragile—a mere sketch on the pale ground, too easy to erase. He needed water to make the green deeper and more durable.

On the derrick's platform, the drillers in gray coveralls and Tinaja, the tall blonde geologist, clustered around the new bit, which they had lifted from its bed of packing material. It looked like a sea serpent's head. Tight plates of metal, edged with dark industrial diamonds, ringed a hollow maw.

Tinaja handed Mark a small piece of paper. Mark unfolded it to read a few words in Ev's graceful but age-shivered handwriting. *This is it. No more.* Mark crumpled and stuffed the paper into his pocket. "Let's use it today."

The foreman attached the diamond bit to the drill pipe. Everyone waited, tense, until he announced that the connection was right and tight. Then the crew lowered the drill stem into the ground. Lengths of pipe, lifted from the stack and locked on one after another, followed the bit into the deep hole.

"It'll take a while to get it down there, won't it?" Mark asked Tinaja. "I need to do something in Creek Canyon."

"Go right ahead. This'll take most of the morning."

Mark headed for the gulch between the hills. Out of sight from the rig, he stopped to pant. This world's atmosphere was high-mountain thin here in the interior.

The gulch opened up onto a canyon, the floor of which was a wet-weather creek, a ribbon of rounded stones. Mesquite fringed the creek. The stringy little trees had long roots that reached deep in the ground, finding moisture from the last rains months ago. Tiny, tough green leaves fringed the mesquite's twigs like tatted lace.

Mark crossed the stony creek bed. On a patch of soft sand under the canyon wall, the fanned footprint of sporadic rain runoff, he discovered the zigzag trail of a small snake—a wondrous trace of animal life in this once-desolate place. Creek Canyon was Chang's territory. Chang did good work.

Mark had told Tinaja he needed to do something in the canyon. True in a way. He needed to think.

A planet wears life like a green skin, he thought, the patterned skin of a snake. Like a snake, the Earth had changed its skin many times in geological history at one catastrophe or

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another, most recently the environmental disaster constituted by *Homo sapiens*. It had never mattered much to planet Earth if, while its continents collided and split wide open above the simmering cauldron of its mantle, its green skin largely died and sloughed off every so often. The death of a snake's, or a planet's, skin only matters to the skin itself.

Humans had been part of a thin, fragile and impermanent skein of life on Earth. Even more so here. If the greening of the continents failed, this planet would endure, uncaring. But the human colony would be forced to live beside the shallow seas, in domes like surf bubbles that shimmer for a little while, then pop and vanish.

No. This raw land had to become a place for mesquite and snakes and people to exist under the wide blue sky.

With a groan, Mark stretched out on the sand in the shade of the canyon wall. Overhead, the zeppelin floated away with a mechanical purr that barely distorted the silence. In the canyon, a grasshopper trilled. One of the grasshoppers of the admirable Chang.

Mark woke up in full hot sunlight. In the distance, he heard the derrick with its signature clangs and bangs. He broke into a sweat, remembering Ev's note. *No more.*

Mark returned to the derrick at high noon. Unbuffered sunlight blazed down. Near the derrick, the field of boxy solar energy collectors threw off dazzling reflections. Heat shimmered over the roof of the powerhouse from which electrical cables snaked away to the dome, the shop and the derrick.

They had stopped drilling. The crew languished on the platform, sitting or lying down under tarps hung up for shade. Only Tinaja seemed alert and unwilted as she picked rock chips out of the sieve.

Mark ran up to join her on the platform. "Can the diamond bit cut the caprock?" he asked.

"Does good," she answered. "Want some lunch?"

Knees weak with relief, he sat down. "Yes, thanks."

Tinaja handed him a metal plate. To his surprise, beside the pile of cooked prickly pear cactus on the plate lay several little chips of rock, clean and moist. Drill chips right out of the sieve. "Tinna, why are you serving me rocks?"

"That shiny bit broke through the caprock an hour ago," said Tinaja. "Into soft old limestone." She pointed at the rocks in his plate and grinned at him. "There was a sea down there once, and may just be some of it left! Will salty water be OK?"

Salt water would be wonderful, Mark muttered in his sleep that night. Salt water would be wonderful. Residual adrenaline smoldered in his nerves like embers in ash. Finally Mark snapped wide awake in a cold sweat. Pulling on his clothes, he left the dome.

The wind outside blew as cold now as it had been searing hot at midday. Overhead the sky was clear, strewn with scintillating stars.

Near zenith was a thin, ragged ring

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of pale nebulosity. The astronomers said the ring marked the death of a giant blue star so near that it would have washed out all of the other stars in the dark night sky. But it evolved rapidly and exploded, supernova, tens of thousands of years ago, a cosmic catastrophe in geological time, leaving a nebula around a neutron star.

Yellow light shone in the window of Tinaja's lab in the shop shack. Mark had meant to start one of the nocturnal walks for which he was notorious; he changed his mind. At the door of Tinaja's lab, he knocked before letting himself in.

Tinaja was engrossed in her work. She had a computer running, its screen split four ways, text disks and printouts strewn about the table, and cylinders of stone in front of her, plus rocks and sands in at least ten piles, and a microscope. Wisps of honey-colored hair had escaped from her ponytail.

"I took a core sample," Tinaja announced. "This is the supernova layer. There are isotopes aplenty. This planet was cosmically irradiated, all right, but good."

"That's great! That you found geological evidence of that, I mean."

Tinaja made a wry face. "Look in the microscope."

The magnified shapes, though worn and fuzzy, were insistently reminiscent of regular geometry. Mark saw spirals, cones, fluted spars and tiny boxes. "Microscopic marine shells."

Tinaja said flatly, "Right. This is, after all, limestone. But the variety of the shells is phenomenal, compared to the species that exist in the seas now."

"From the Near Supernova layer?" Mark's skin crawled. "There must have been a die-off. One that the world hasn't recovered from."

"Look." She held out a curved, rough cone about an inch long. "Found this in the core sample. It was sheer accident that the whole thing was inside the core."

"Worm shell?" Mark guessed.

Her face was intense. "I don't think so. Granted, this is an alien world. Who knows how evolution goes here? But Mark, I think it's a tooth. Look—see how it's worn flat, here? Predators' teeth get wear patterns like that. Worm shells don't."

Sheer shock made Mark feel cold and numb.

"Mark, what would have happened if this world had an extensive ecosystem?" she whispered. "What if it had been like Earth?"

Appalled, Mark forced himself to marshal his education in life sciences and answer her. "The atmosphere must have been partly stripped away and the oceans boiled off to shallow seas. Enough marine microorganisms survived to recolonize the seas. But on land, judging from what we found when we got here, there was nothing left. The continents must have been sterilized. It was as though the evolutionary clock were set back." He swallowed with difficulty, his throat constricted. "Almost to zero."

Three hours before dawn, the foreman flipped the main breaker at the powerhouse. The drilling rig's lights came on. The crew checked their equipment. There was little of the

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usual banter and horseplay this morning. Two miles down, hole heating up and pipe supply dwindling, today looked like the last day, one way or another.

The foreman replaced the corer, a hollow sharp-rimmed cylinder, with the diamond drill bit. Then the crew lowered the bit into the ground. Joints of pipe followed it, each attached swiftly but securely. Time passed, metered by the clank of pipe being joined to pipe.

Mark felt nearly sick. He'd had too many broken nights and too much work, and now there was a fossil tooth—evidence of sudden death on a planetary scale. Visible through the thickness of the atmosphere near the western horizon, the shredded supernova ring shimmered like the winking of an eye, a vast lidless eye with a tiny, implacable pupil.

The plunging pipe changed its tune, decelerating. Tinaja called out in a clear voice, "We're here."

A small crowd of greeners had come out of the home dome to watch. Somebody slapped Mark on the back and blurted something about luck. Whether they believed in Mark's dream or not—opinion was distinctly divided—the greeners wanted water.

Mark joined Tinaja on the platform. The drill bit met solid limestone far below their boots. The foreman sent the helper, a boy named Dusty, up the derrick to mind the moving parts at the top.

Two miles long in a hot, narrow hole, the pipe behaved like a wet noodle. It took several turns at the top to get any rotation at the bottom to cut the rock. The mud pumps ran at full throttle, forcing cool mud down the throat of the pipe. The mud came back up the hole outside of the pipe, carrying rock chips and heat with it. A fat hose took the mud back to the tank, dumped it in through the mechanized sieve called a shaker. The shaker rattled mindlessly. Thick and grayish-brown, the mud cooled in the open tank. An automatic stirrer made swishing sounds.

Tinaja paced between the rotary table and the shaker. She scraped chips of rock out of the shaker and examined them. She patted the pipe. "Down some more, baby, down some more."

Machinery rattled and clanged, and the pipe turned tirelessly. Mark saw the knife edge of dawn, a thin rim of light on the eastern horizon. Directly overhead, a bright point of light traversed the dark sky. It was the Starship in polar orbit.

"Pay attention, skygazer!" Tinaja said sharply. "The mud's changed!" She crouched beside her shaker, watching the mud stream through it, heedless of the spatters. "Frothy."

"Watery?" Mark asked instantly.

"Maybe. Maybe not."

Mark stared at the twisting snake of pipe. A scar on the metal revolved with it and slowly moved down.

Some mud bubbled up over the rotary table. The foreman watched it inundate his boots. Over his head the returning mud hose suddenly twitched. "Is the planet fartin' at us?" asked the foreman.

"I don't think that's possible," Tinaja replied in an uneven voice.

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With a loud burp, mud spurted high out of the hole in the middle of the table. On his perch up in the derrick, Dusty ducked. "It's throwing mud at us!" he sang out.

"You're not safe up there," the foreman decided. "Come down."

A minute later, a brief gout of mud came out of the hole. Mud, with rocks in it, rained down on the platform. "I've drilled up a lot of water, but never seen the likes of this." The foreman sounded uneasy.

Dusty scurried over to peer into the mud tank. "It's making bubbles and the mud's higher in the tank than it was!" he reported breathlessly from the edge of the platform by the tank.

"Mixed with water?" Mark demanded.

"No sir, it's just really foamy."

Another gout of mud, a hard one, shook the pipe.

In a sharp voice, Tinaja told the foreman, "We can't have any sparks. If this is some kind of natural gas, then it could be flammable."

The foreman nodded, then grimly started checking around for moving parts that might strike sparks, or loose electrical connections that could arc.

To Mark, Tinaja muttered, "Natural gas is not supposed to exist on this world—but neither are teeth. Maybe there is a kind of natural gas down there. It might or might not be associated with water." She cursed briefly and vehemently. "I never studied this in ship school!"

The scar on the pipe turned around and around without going down. Mark approached it, leaning as close to the pipe as he could, heedless of the mud piling out onto on the table. He asked, "Why have you halted the downward motion of pipe?"

"I haven't," said the foreman.

"But it's—"

The pipe slithered upward in front of Mark's face.

Swearing in surprise, the foreman tried to clamp the pipe. The upward thrust of it tore the clamp apart. Accelerating, the pipe broke something high on the derrick. A piece of metal fell clanging down. Tinaja yelled, "Can't you stop it?"

The foreman bellowed back, "No! There's godawful pressure under it!"

The platform shook spasmodically. Dusty lost his balance. Letting out a terrified yell, he slipped into the mud tank with a thick splash.

Closer to the tank than the others, Mark shouted, "I'll get him!" Holding a jittering railing, Mark reached for Dusty. The boy's muddy hand slipped out of Mark's.

The pipe thrusting itself up out of the ground muttered and moaned, noises that vibrated through the platform. Mark heard a shriek from strained metal at the top of the derrick. Tinaja screamed, "It's breaking the rig apart! Run!"

With shouts and curses the drillers and Tinaja leaped off the platform and scattered. On his third frantic try Mark got a handful of Dusty's shirt. Dusty scrabbled to get some leverage for himself on the slippery side of the tank.

The hole roared. The platform rocked. Mark almost fell into the mud tank himself. Then he hauled Dusty

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out while mud and rocks and metal parts rained on them. Dusty shrilled, "It's shooting into the sky!!"

Dusty meant the pipe. Drill pipe arched high in the air over the derrick. It was being thrown up out of the hole—lofted by gas escaping from underground. The platform quaked. Glowing light bulbs swung wildly on their cords. Any moment now, one of them would smash into shards and sparks.

Mark threw Dusty off the platform and the boy hit the ground running like a jackrabbit. Mark jumped down and angled away from the platform as he raced toward the powerhouse. In the corner of his eye he saw hundreds of feet of noodle-soft pipe still shooting up into the air.

Gravity overtook the airborne pipe. A loop of it hit the ground in front of Mark. Thundering, it broke up, thirty-foot lengths bouncing wildly. Mark cowered. But he had to reach the powerhouse. He jumped over a steaming length of pipe to get there.

Tinaja reached the powerhouse just ahead of him. He nearly collided with her. She grabbed the derrick main breaker and threw her whole weight to turn it off. Then she looked past Mark and gasped. "*Too late!*"

Mark turned, his stomach knotted with dread.

Fire flared above the derrick. Heat from it struck Mark's face.

The hole under the derrick threw up another gout of mud. Choked, the fire shrank dramatically.

"Now what?" Mark asked hoarsely. Tinaja just shook her head.

They stood closer to the derrick than anybody else. Spectators and drilling crew had fled to the nearest hill with the last of the pipe crashing to the ground at their heels. His eyes transfixed on the damaged derrick, Mark moved in front of Tinaja, for the little protection that he might give her.

The derrick coughed. Then it threw up thick globs of fire. Mark groaned in dismay. His dream had come true, the right image in terrible wrong colors, like a demonic photographic negative. What should have been pale and cool burned instead: a geyser, not of water but of fire. Black smoke coiled into the sky. The derrick howled and shook. Ropes of orange fire coiled up into the air and fell back to the ground, splashing flame. Tinaja let out a shrill cry of dismay. "It's oil! Oil burning!"

Around the derrick, clumps of dry grass caught fire. The wind blew up a swirl of thin brown smoke, and the smoke pointed toward Chang's Creek Canyon.

Mark shook off the mesmerization of the flames. He took Tinaja by the shoulders. "Run to the dome, raise the alarm and radio the Ship for help!" Without a word she sprinted away.

Mark charged uphill, toward the greeners and drillers, waving his hands. "Wildfire! Equipment to the Creek!" He panted. "Sand plan!"

Shovels and buckets were cached near the dry creek. Greeners and drillers broke out the tools and frantically shoveled sand over the cacti to protect the plants' roots. Disturbed grasshoppers jumped and flew short distances.

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The firebreak executed so carefully, just yesterday, to guard the canyon, utterly failed. Mark knew that it would. Spurred by the hellfire of burning oil spewing out of the ground, the grass fire rapidly sidled around the firebreak in the gulch.

The front edge of the fire penetrated Chang's Creek Canyon. Burning bits of vegetation flew through the air.

"Fall back—across the creek bed!" Mark waved everyone across the stony bed of the dry creek that might halt the fire and help them save this, the shadier and greener side of the canyon.

Mark flung the lid off the nearest flood cistern. He plunged a bucket into the warm water. Drillers and greeners threw water on the vegetated ground and splashed the mesquite trees in desperate haste.

An isolated fire flared up in the bushes under the canyon wall. Side by side, Mark and Chang beat it out. Chang had no words of recrimination to spare for Mark. Not yet.

A sudden and startling mechanical noise reverberated in the canyon. Mark looked up, stricken by hope.

An airplane thundered overhead. It banked. On the second pass, the plane dumped a dense streamer of orange powder onto the fire in the gulch.

Coughing, Mark recognized the harsh chemical. *Deus ex machina,* the firefighting squadron had descended from the Starship in a shuttleplane loaded with fire-suppressing chemical. The plane circled back to release another load. Then it banked toward the column of black smoke in the sky beyond the gulch.

Mark told Chang, "Check around for hot spots and put 'em out."

Chang nodded, expressionless.

Mark recrossed the stony creek bed. The mesquite trees on the bank, leaves singed off, bore orange powder like a dusting of weird snow.

The chemical had taken the fight out of grass fire. Only a few patches sullenly smoldered. Mark emerged from the bitter smoke in the gulch just in time to see the fire squad's plane making a brave pass at the fiery fountain spewing out of the drilling rig. The plane tossed an orange plume of chemical at the rig.

The oil inferno barely flickered.

Mark felt detached, like a spectator at a grand and tragic show. He watched the derrick collapse, its metal girders melted, inside the flames.

Something new flew down out of the sky. Not another lumbering shuttleplane: this was a screaming splinter of a jet. The jet charged toward the towering fire. Then the jet pulled up, releasing a dull gray object to tumble down and explode in the midst of the fire.

The bomb's shock wave flattened and extinguished the flames.

Mark cheered wildly.

Wreckage and dirt fell over the drill hole. But black oil still came out of the ground. Not ablaze anymore, the oil spurted like blood from a cut artery.

The jet arched and returned. This time it hurtled low over the singed landscape. It dropped a second bomb directly onto the hole in the ground. The cratering blast shattered the rock, stopped up the hole. Only a little

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more oil oozed out. The jet screamed away.

Mark's ears rang from the two explosions. He did not know how long he had been standing here watching the attack on the fire. It seemed to be nearly noon now.

Mark gave the black, oily bomb crater a wide berth. Yet he found a blob of oil in his way, flung far by the bombing, sticky and smelly, the ancient dark blood of the planet.

The wildfire had run through the field of solar energy collectors next to the derrick. The structures drooped over the charred grass. In the distance, the green grass sketch on the hills had turned ugly, charcoal splotched with lurid orange.

The home dome seemed deserted. It was not flammable, so no one had stayed there to worry about it. Mark fed the spider her overdue breakfast. She was important. A symbol of the web of life. Of which the most vital strand, for the life of continents, was grass. Mark sat down at the kitchen table. Hard hot daylight beat down on him through the skylight, since no one had closed the shutters. Shaking, he folded his arms, buried his head in them, and cried.

Someone shook him by the shoulders. "Mark! Are you hurt?"

Mark flexed his hands. Under a crust of sooty dirt, his raw skin oozed blood and blister water. He shuddered. He looked up at Evrett Reynolds. "How come you're here?"

"I was watching from orbit," said Ev. Behind him stood Tinaja, disheveled, her face pale under streaks of soot.

Ev went on, "I watched the terminator sweep toward your part of the planet. Then I saw the flare. It was incredible—there shouldn't have been that much fuel on the entire continent. My people analyzed the flare immediately. Then they did a data base search for how to fix an oil well blowout, which is what that kind of thing is called. I came down with the fire squadron."

Tinaja pulled Mark over to the counter sink. She started cleaning his blistery burns with soap and water from the kitchen reservoir. Mark's fingers and palms hurt fiercely. The pain seemed irrelevant. Through a scratchy, aching throat, he said, "I opened up the gates of hell. It burned up the grass." Mark felt a quiver in his insides. Maybe he was going to be sick. Or sickeningly sad.

"Mark. Where does soil polymer come from?" Ev asked.

"Garbage. Our conversion rate is up to thirty-seven point six percent," Mark said defensively. "It's the best I could—"

"You've done fine recycling around here," Ev soothed. "Polymer comes from garbage after you process it, more or less turning garbage into petroleum. We've been making all of our petrochemicals that way."

Tinaja gasped. "*Petrochems!* I studied that in Ship school. We examined precious little samples—plastics, solvents, fertilizers." She pulled a wrinkled tube of burn ointment out of her pocket. "Medicine."

"Petroleum is the most useful stuff in creation," said Ev. "We had no idea that it existed on this planet—that

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there'd ever been plant and animal life in such abundance as to turn into reserves of oil—except for one round of speculation years ago. Too far-fetched to waste resources looking into, I thought." Ev sighed deeply.

Tinaja smeared burn ointment on Mark's hands. Mark leaned on the counter. He felt dizzied, as new ideas surged and glittered in his mind. Star-burned ecosystem. Petrochemicals. Soil polymer. Holding up his dripping hands, he blurted, "Now we can green the land!"

"What?" Tinaja asked. "How?"

"Let me demonstrate." Ev produced a vial from his coat pocket and poured a small pile of substance on the counter. "Soil polymer."

Ev sprinkled water onto the polymer. It absorbed the water like a sponge. He dripped more water onto the polymer, which kept sucking it up, swelling. The scant handful of plastic sand turned into a gelatinous mass.

Tinaja poked the swollen polymer. It quivered brightly.

Mark straightened. His back ached, but the weight of the world had just rolled off his shoulders.

Ev explained, "This material absorbs four hundred times its weight in water. Mixed in the soil, it does wonders for water retention. With enough of it, Mark's outfit can turn this land green as grass. Not in my lifetime, but in yours."

Tinaja let out a joyful cry and flung her arms around Mark. She exclaimed, "Surely the oil isn't just here—there must be reserves all over the planet!"

Mark's heart lurched at hearing another and even brighter hope than he'd expected, like the sun rising after the first flush of dawn. "Then we'll use it to make the whole world green again." He returned Tinaja's embrace as Ev beamed at him over her shoulder. "Not in our lifetimes," Mark added. "But someday." ■

Editor's Note: This story is a sequel to "A Pillar of Stars by Night," which appeared in our January 1996 issue.

The promised land always lies on the other side of the wilderness.

—Havelock Ellis

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SPACE DRIVES, PHASED ARRAYS, AND INTERFEROMETRY

Announcement: Would you like to see back issues of this column? Electronic copies are now available on Internet/WorldWideWeb as HTML files, with both subject and chronological indexes. About 80 of my columns are available, published in *Analog* between July 1984 and a few months ago. I plan to add one column to this archive each time a new one is published in *Analog*. The URL address for this Alternate View column archive is: http://www.npl.washington.edu/AV

When I was about 16 years old I found a remarkable Letter-to-the-Editor printed in the "Brass Tacks" section of John W. Campbell's *Astounding Science Fiction* (the previous incarnation of this magazine). The letter described a "magnetic space drive" that seemed very likely to actually work. This column is about interferometry, but I will start by describing that space drive, which, in a sense, is an interferometer.

Here's the magnetic space drive setup. We place two bar magnets, each perhaps one inch long, at a center-to-center separation of six inches, with the bar magnets' long axes lying on the same straight line. We arrange the magnet poles so the north pole of magnet A is closest to the south pole of magnet B. In this configuration each magnet experiences an attractive force, pulling it toward the other magnet. These forces cancel, so that there is no net force on the two-magnet system.

Now the trick: we rapidly flip magnet A, so that its poles are reversed. Magnet A is in the field of magnet B and now experiences a repulsive force in the direction away from B. However, magnetic disturbances travel at the speed of light. Until the field change arrives about half a nanosecond after the flip, magnet B remains in the unreversed field of magnet A and will still experience an attractive force in the direction of A. Thus, B is attracted to A while A is repelled from B. Therefore, the two-magnet system has a net force on it, pushing it in the direction from B to A.

This net force is transitory, but it can be maintained indefinitely by repeated flipping. Just as the field change from A arrives at magnet B, we flip the polari-

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ty of B. Since arrival of the field change and the polarity flip happen simultaneously, B is still attracted to A. And for the next half nanosecond while B's field change propagates to A, the magnet A continues to be repelled by B. Again the two-magnet system experiences a net force in the direction from B to A. And when the news of B's reversed field reaches A, we flip A. And so on . . .

The result of this programmed magnet-flipping is that the isolated two-magnet system has a roughly constant net force acting on it. If isolated in space, the system will accelerate, gaining velocity, momentum, and kinetic energy. It is therefore indeed a "magnetic space drive." It also appears to present a physical paradox, in that it seems to be violating Newton's 3rd Law of Motion (momentum conservation) with extreme prejudice.

I carried this puzzle around with me for several years in high school and college before I finally worked out what was going on. I was a physics major in college and struggled to learn enough mathematics and electromagnetic theory to analyze this magnetic space drive properly. Finally I succeeded.

One can view the system as a pair of magnetic dipole loop antennas that are driven 90 degrees out of phase and spaced a quarter of a wavelength apart. Careful analysis of the forces shows that the overall system will indeed experience a definite (but small) net force. But there is also another effect: each of the magnetic dipoles is an antenna that emits radio waves, and because of their separation and phasing, the waves on one side along their mutual axis will tend to cancel, while the waves on the other side will tend to reinforce. It is a "beaming" antenna system, known in radio lingo as an "end-fire antenna." It has the property of transmitting radio waves in a particular direction in space. The beamed waves travel in the direction opposite that of the net force, and the force is the "radiative reaction" to the momentum carried away by the radio waves.

Therefore, the magnetic space drive will work. It uses radio waves in place of a rocket exhaust and recoils in the opposite direction, just as Newton's 3rd Law says it should. The down-side of this device is that the force you get for a given amount of expended electrical power is extremely small. The reaction force is the net radio wave power divided by the velocity of light so developing a thrust of one Newton requires 300 megawatts of power, about the output of a medium-size nuclear power plant. The magnetic spacedrive works, at least on paper, but requires too much power to be of any practical interest as a propulsion system.

However, the device is interesting for another purpose. If we use the two-dipole antenna system as a receiver instead of a transmitter, it is sensitive to incoming waves coming from the same direction in which it tends to broadcast. The directional effect can be enhanced by adding more antennas to the system and mixing their received signals with appropriately chosen phases. Such a phased array of antennas is standard in radio astronomy

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and can be used to transmit or receive radio waves with pinpoint accuracy.

Combining the amplitudes of the signals from such an antenna array is called *amplitude interferometry*. It is a very powerful and widely used technique. The directional accuracy of such an array is limited by diffraction, the tendency of waves to distort and spread at the edges of an aperture. Two radio sources (e.g., quasars) separated by an angle X can be distinguished if X is greater than about w/d, where w is the wavelength of the radio waves and d is the diameter of the system of antennas used to detect the waves. The same relation holds for optical telescopes, where w is the wavelength of the light observed and d is the diameter of the telescope aperture. This places a large premium on having a large value of d, since this makes the angular resolution X very small. In radio astronomy, "antenna farms," radio telescopes like the Very Large Array at Socorro, New Mexico, an array of 27 dish antennas configured in a large "Y" 20 km on a side, are used to obtain very good angular resolution. [For more information, see the VLA website at http://www.nrao.edu/vla/html/VLA or ig.html] On a larger scale, widely separated antenna complexes record radio waves with precise timing and phase information. The recordings are later combined and used to provide the equivalent of a radio telescope with an Earth-diameter aperture. Optical telescopes are now being developed that will extend this kind of amplitude interferometry into the optical domain.

The amplitude interferometry techniques, however, apply only to sources of coherent waves, e. g., radio waves from a single antenna (or light from a laser), that come from a single source and maintain a continuous phase across a broad wave front. This limits its uses in optical astronomy, because most stars are incoherent light sources (like a light bulb). The light from different parts of the star's surface has no consistent phase relation. Fortunately, there is another kind of interferometry that can be used with incoherent light sources. It was invented by the radio astronomers Hanbury-Brown and Twiss, and it is called intensity (or HBT) interferometry.

The Hanbury-Brown-Twiss trick is to multiply the signals from two dish-antenna detectors instead of adding them, as would be done in amplitude interferometry. This is equivalent to imposing a requirement that photons from the source are detected by both detectors simultaneously, in good time coincidence. They showed mathematically that the strength of the multiplied signal depends on DS, the product of the diameter D of the star producing the observed radio waves and the separation S of the detectors receiving the waves.

Hanbury-Brown and Twiss mounted their antennas on a carriage that allow them to be moved to change their spacing S and pointed them at a nearby star. They found, as expected, that when the dishes were close together and S was small, the multiplied signal was strong. But as the dishes were moved apart and S was increased, the signal decreased. The disk separation S(1/2) at which they

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receive a signal that was half the maximum value was used to infer the diameter of the star. Using this technique, the diameters of many nearby stars were measured.

HBT interferometry works only with incoherent light sources. As the source becomes coherent, the multiplied signal goes to zero. It works best when the ratio (DS)/(Lw) has a value near 1, where L is the distance to the star and w is the wavelength of the radio waves used in the measurements, and when the detected particles are identical bosons, i.e., particles like photons that have integer rather than half-integer spins. [See my AV column in the March 1995 *Analog* for a discussion of quantum spin statistics.]

HBT interferometry teaches an interesting lesson about photons. Particles like photons cannot consistently be described as blobs of mass-energy which travels through space from point A to point B. The enhancement observed in HBT interferometry implies a more complex picture. The detection of waves from source points at the right and left edges of the disc of a star can be considered as removing one energy quantum (hc/w) from each of the two source points and delivering one energy quantum (hc/w) to each of the two detectors. For many combinations of source and detector separation distances, the detected waves are nearly opposite in phase, so that the composite wave is very weak and the detection event is very improbable. For a few ideal combinations of source and detector separation distances, however, all of the composite waves are strong because their components coherently reinforce. In this case the detection event is much more probable, as predicted by quantum mechanics.

However, neither of the photons detected at A or B can be said to have originated uniquely at one of the two sources. Each detected photon originated partly in each of the two sources. It might be said that each source produced two partial photons and that fractions from two sources combined at a detector to make a full size photon. Thus, photons are not little baseball-like energy packets that travel in a straight line at the speed of light. They must split and combine as waves. Their particle aspect is an illusion created by the quantum boundary conditions for emission and absorption. Photons have no unique identity except when they are emitted or detected. That's part of the weirdness of quantum mechanics.

HBT interferometry also has another application, in a completely different area of physics. My field of research is ultra-relativistic heavy ion physics. I and my co-workers study collisions between heavy nuclei accelerated to the highest energies we can manage, which at the moment is 33 TeV lead ions accelerated at the CERN SPS accelerator.

In these collisions thousands of pi mesons are created. Pi mesons have a spin of zero and are therefore bosons. If we use the wavelength of a pi meson for w, the size of the colliding nuclear system for D, and the size and separation of components of our particle detectors at CERN (a few meters) for S and L, the ratio (DS)/(Lw) is

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around 1, just as in the radio wave case. This allows us to use HBT interferometry to measure the sizes of the ultra-hot fireballs produced in our nucleus-nucleus collisions. We've been using this technique on our data for some time with good results. The ultra-hot fireballs we produce show very interesting size and expansion characteristics.

And there's another interesting quantum moral here. The pion "particles" we detect are usually considered to be particles, tiny combinations of a quark and anti-quark locked in a strong-interaction embrace. But they are also identical bosons.

The fact that HBT interferometry works with pi mesons tell us that they are no more baseball-like particles than are photons. They are also manifestations of quantum boundary conditions for emission and absorption, and detected pions are being assembled from particle "slices" supplied by many separate and incoherent emission points.

Particles are an illusion. That's part of the weird and wonderful Universe in which we live. ■

If we as individuals are to have the freedom—the ability to make choices—that an adult is entitled to, then a necessary correlate of that right is that we must hold ourselves responsible for the results of those choices. One obvious answer to someone who says "I am not responsible for my own actions" is, "Then you are not entitled to a full level of adult freedom, but only the amount which you can be held responsible for."

—Henry G. Stratmann

The more you read about politics, the more you got to admit that each party is worse than the other.

—Will Rogers

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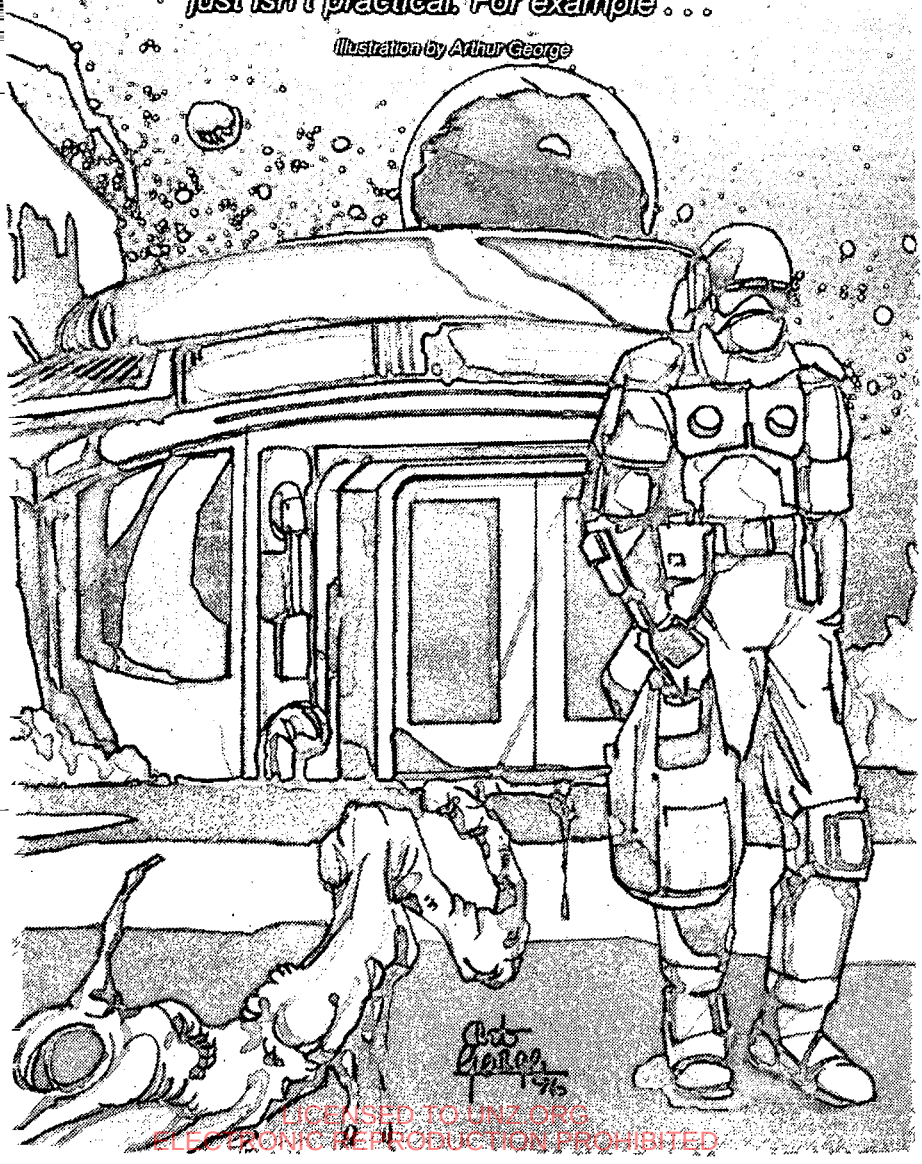
Laurence M. Janifer

POEMS ARE MADE BY FOOLS LIKE ME

With a job like Knave's, a "job description" just isn't practical. For example . . .

Illustration by Arthur George



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1.

Very few planet-testing assignments are worth reporting on—except, of course, for the tech reports I do have to make. Those are what the Comity pays me very poorly for, and they are still worth writing. With any luck, they will not only make me a pittance I couldn't possibly learn to live on, but they will actually save lives, anywhere from one to an entire shipload, or even more if the place reports out as uninhabitable—uninhabitable despite, of course, the wonderful descriptions everybody was so pleased with when the drone ships checked in.

Let me explain how planet-testing works. If you already know this, skip ahead to the double-space, or the beep, or the sunburst, depending on how you're getting this. If you don't, though—and a lot of people don't, because they have the idea that it's like the stuff on 3V with the heroic Survivor and his twin blasters and his laconic swagger, or whatever the hell that is:

The drones come first. Drones are big awkward ships that go out to where a new planet is supposed to be. They go out by, or through, or during, space-four, which means that every once in a while we lose one. God alone knows where a lost drone might show up, and one of these days we're going to find one crossing the (space-four) path of a ship with something alive in it, and some poor bastard at Colonization, who may not have been anywhere close to having been born when the damned drone set out, is going to be fired.

The ones we don't lose end up where they are supposed to end up, and usually, to my continuing surprise, the planet is really there, and the drone takes a lot of readings from an orbit around the place that is not supposed to be detectable from planet-level. For all I know, it really isn't; I have never tested for it.

The readings tell Colonization what the atmosphere is like (in magnificent detail), whether there is noticeable EM radiation of any sort (and what sort, and does it have patterns we can distinguish, and does it localize for specific points on the planet, and does it vary unusually with local night and day for any point on the surface—and much, much more), whether there is detectable animal—or vegetable—or mineral, I suppose—life down there on the ground, in the water or in the atmosphere, what the local sun's spectrum is like in very close and agonizing detail, what planetary temperatures and visibilities are likely to be at a staggering variety of latitudes and longitudes during the planetary year . . . and so on, and so on, and so on. As all this is squirted in a single beam back by space-four (well, a triple beam, because beams get lost even more often than drones), a magnificent array of informative data comes back to Colonization very, very quickly, and Colonization can then make up its mind what to do next.

It always makes up its mind the same way: it calls me. Or if not me, one of the other people in my trade (and there are not many people in my trade, because there is plenty of room at the bottom, but a good deal of it is

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room in rather small boxes, under headstones).

It wants to know whether the new planet is habitable.

Didn't the drones tell it that? you may ask, and the answer is no, they *can't* tell it that, and I'm sorry to have to advise you that you have asked a stupid question.

The drones tell us only what the bare scientific facts are, even though there are a hell of a lot of bare scientific facts. These facts enable me (or some other poor bastard of a Survivor) to request, and usually obtain, a great deal of equipment when I set out, some of it actually right for the parts of the planet I'm going to be on: sunshades for worlds that are brilliantly, hotly lit, lots of ointments and small-field generators for worlds that are rich in muck and spongy growths of one sort or another, large-sized weaponry for worlds that appear to have large-sized, oppressive (and unintelligent) animal life, and so on.

What I do with whatever stuff I have brought, of course, is set up housekeeping. My job is to live on the planet for a standard year (not a planetary year; this would in theory be a good idea, but some planetary years are fifteen standard years long, and we would all be bored by then. Or, of course, dead). When that year is up, a drone ship comes looking for me, and I climb aboard, and report back to Colonization—which at that point can have a fairly good idea not whether the place is theoretically and scientifically livable, but whether human beings can live on it. If you think these two things are the same thing, you have a positively awesome faith in the practical value of theory.

I am also equipped, at the end of my year, to tell Colonization what a colonist actually *does* have to bring along. It is seldom what the scientific data assured me *I* had to bring, and the difference is that the new list works.

Sometimes, in brief fact, the planet does get inhabited by human beings, and gets quickly stitched into History, which means that a lot of other human beings hear a lot of inaccurate, if stirring, stories about it. But the story of my standard year wandering around the place looking for trouble is, as I've said, seldom worth telling except to Colonization. Once in a while—Rasmussen will serve as a fine example, if you know the place, with its biting saurians and its very odd multiple society—the story is simply not printable, not even today.

But just once. . . .

I was living in Florida at the time. Florida is on Earth, and it isn't called Florida anymore (most of it is now called Under Water) but, against challenging odds, a little chunk of island is still around to be lived on. It was once called Key West, though whether it was shaped like a key or whether it had once been thought of as the Key to West Something-or-other I cannot tell you, and I was living there for a very sentimental reason. I had fallen in love again.

What I had fallen in love with, for the fifteenth or twentieth time, wasn't human, or even animal: it was a sort of dessert concoction called Key Lime

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pie. Pies haven't been fashionable for forty or fifty years, and it's a shame, because a good pie—apple, mince, or even custard—is a work of art, possibly a little too Primitive for fashionable folk, but of course that leaves all the more pie for thee and me, if thou art a sensible soul, and if thou artn't, go hunt up a Key Lime pie recipe and learn better.

Ordinary limes can be picked up anywhere, really, and so can the rest of the ingredients, but Key limes (limes from this Key of an island) are specifically called for, and there are still some nicely flourishing lime trees on the place. As far as I know, I have been the only human inhabitant of Key West for at least the last thirteen years, and I go there—there's a wood-and-metal house, parts of it still standing, that serves as my Key West Cabin—when I need Key Lime pie again. It is lovely stuff, and it deserves an authentic setting if one can be provided.

I had planned a fairly good dinner one quiet evening, and my Totum and a couple of Robbies were doing the dull preparatory work (I allow them that, but the cooking, not to mention dishwashing and the like, is all mine; dishwashing, by the way, like solitaire or crossword puzzles, is a fine way of busying the mind a little without actually occupying it, and I have done some of my best thinking near hot, soapy water) while I watched the sunset. I have heard somewhere or other that sunsets in and around Key West were spectacular even before the Clean Slate War. For a brief while after that they must have been unbelievable, and they are still pretty good today, or tonight, or, in fact, whenever it is you're reading—or hearing—or otherwise assimilating—this rambling report.

The dinner involved seafood, of course—what else, on a very small island?—and was to be topped off by Key Lime pie and coffee. Kona beans are usually a little too sweet to be used alone, but they work awfully well with that pie, and I had some good Kona along to grind just a bit later in the proceedings. I felt wholly at peace with myself, the Universe, and the cheerful prospect of nourishment, and when I heard the beep I thought for one second that it was my Totum telling me things were ready for the Master's hand.

Unfortunately. . . .

I do try never to turn down an assignment; that sort of behavior can give one a bad name, for some damned reason. And I did manage to sell the Colonization sahib who had managed to reach me on the idea that it would make no real difference if I reported to him some time the following morning, rather than in four hours, which would be, after all, fairly late in the evening even for Grand Forks, Idaho, where for some damned reason most of Colonization lives.

I told the fellow that I had to do a little research on the drone reports. God knows I did have to look them up. But I could have them beamed to me aboard my ship, en route, in the morning, and so I did.

I made an extra pie, to take with me and eat on the way to Tree.

I hereby swear and attest: the planet was officially named Tree. I have

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run into as many funny-sounding planetary names as anybody, I suppose, short of a galactic surveyor (one of my favorites is Copious, which seems to have been named by mistake; some born damn fool thought it was an ancient-language word for Body—his name was Hubert Boddy, and he thought he'd back into History that way), but Tree hit a new sort of low. Its basic difficulty is that it is the fourth planet in the system, counting from either end (there are seven, and it's in the middle), so you can't get away from: Is that Four? No, dat's Tree. There must be something better for Colonization to do than think up bad straight lines.

The place does have trees, though; I'll give it that. The course bumps beamed onto my card gave me a trip time, through space-four, of nearly four days (though of course that doesn't mean anything in terms of normal three-dimensional distance; it's two days and a bit Earth-Mars, if you ever want to do that jump the hard way, and a couple of hours under two days to Alphacent, which is noticeably further away), and I spent my four days (once the pie was gone) reading drone reports, looking at drone pictures, and generally Droning. If the planet had one thing, it was certainly trees.

Not that they were Earth trees, of course—but they looked a lot closer to that model than anybody could have expected. They were tall things (four feet for teenies, fifty feet for big bastards, and everything in between added in, for sixty or seventy slightly different breeds of foliage) with branches and leaves—though the branches weren't individual things but a sort of hard flattened twining material that thinned out toward the ends but never quite became fully unified. The leaves weren't soft green chlorophyll contraptions, either; they were a sort of yellow-tan, very light in color for the most part, and much harder, it turns out, than leaves on Earth trees. They occurred in the thousands on every tree; the leaves were not only collection-plates for nourishment from solar energy (they were the point men for a sort of calcium bond system that worked instead of chlorophyll, but the details are thoroughly hairy, if you don't mind), but collection-plates for small animals, of which there were millions upon millions.

The trees, or the leaves, emitted something—at that stage nobody had any idea what, since there are limits to the information even a drone ship can collect from orbit—that attracted small animals. Almost bonded to the actual leaves was a sort of translucent surface that rolled up quickly and digested the animals. Every tree its own king-sized, slightly odd, Venus flytrap.

But they looked a lot like Earth-normal trees from any reasonable distance—the color was something my eyes adjusted to easily enough—and they occurred in groves and stands and forests and jungles all over what seemed to be the main continent. The oddity, if you collect oddities, was that no single breed of tree dominated a grove, stand, forest, or jungle, for the most part—statistical flukes occurred, but they were obviously

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flukes; all the breeds existed happily, and in brotherly calm, everywhere on the planet. Brotherly calm, you understand, is something any Survivor is willing to cheer about.

The planet had six land masses for its trees, four of them a bit bigger, apiece, than Key West. The fifth was about the size of Macallan on Pupil III, if you know it—a little bigger than North America.

The sixth was the size of a *really* large continent. Tree had decided to go out of its way to show the visitor that it could grow continents in style, and shouldn't be judged by pinched and early efforts. The big one was where most of the vegetable and animal life seemed to thrive—except for water creatures, of course, though the liquid that washed about three-fifths of the world wasn't quite water any more than the air was quite Earth-normal air; it was breathable, it did not cause fits or dizziness or nausea, but its figures were just that little bit different, as expected; planets can be siblings, but not, as of right now, identical twins. Though you might not want to take any large bets on that for the next five or six worlds; who knows what the next one is going to be like?

And though there were predators and predatees in the water, as usual exchanging places with each bite, they could safely be left for a little later in my inquiries. My first job was figuring out how to live on land.

I had a portable house. Not a tent, not a jump back into the ship, but a jiffy-building that ran itself up in a hurry—and a good thing, too, because I don't take my Totum and Robbies planet-testing with me, and I am just too damned lazy to build a log-cabin type of dwelling all by myself. It isn't at all like dishwashing, and even less like fine cookery.

I had some weapons, too. The planet didn't look as if it was about to toss up anything wildly dangerous—just the usual animals, more or less, most small and a few surprisingly large, with claws, teeth, serrated beaks, the occasional horn, and other expectable equipment.

Now, most animals, on any world, won't eat totally unfamiliar things. The stuff might be poisonous. It might taste terrible. It might eat you right back.

But in amassing enough data to come to a decision that some one particular thing is really, *totally* unfamiliar, most animals will cause death, and great agony. Rather than give them the trouble of trying me out and deciding that I was not edible—a sheer waste of the animal's time—I carried a variety of weaponry.

And some other things. . . . No sense in running through a full inventory here and now.

So I set up my light housekeeping with heavy weapons, and began making the first, and most important check-list: Things to Eat.

It really doesn't matter if you're perfectly safe—armed against all intruders, nicely supplied with oxygen and so forth—if there is nothing on the planet you can eat, and eat regularly and often. If that's the fact, you're not a colonist, you're a tourist.

The drones had made some spot

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analyses not only of atmospheric components but of chemical properties of local animal and vegetable life. There were a few poisonous things, mostly among the plants (though there was one wondrous animal that looked a little like a giraffe with very, very long ears, which killed its prey by spitting a sort of chlorinated goo at it through a tubed tongue; Mother Nature gets exceptionally weird now and then, doesn't she?), and as usual on almost any world there were a) trace elements missing, which colonists would have to supply either by growing things from elsewhere or by keeping factories of some sort busy, and b) trace elements added, which colonists would have to watch out for by diet regimens and by providing some sort of chelating process if needed to remove the stuff.

But those were minor difficulties, solvable on other worlds and therefore solvable on Tree. I had a good list of stuff it would be safe to eat, or stuff I could fairly easily *make* safe to eat, and I began considering cooking solutions.

These are seldom obvious. Some quite usual Earth foods are foods only if cooked, stored, buried, salted, scraped, or otherwise treated for lengths of time ranging from ten seconds to ten years. We've had millennia to figure out how to eat shark, or Jerusalem artichoke, and the human race could manage perfectly well, as far as health and even basic pleasure are concerned, if shark steaks and Jerusalem artichokes were both suddenly canceled from the Universe.

I had a year—a year that was going to be interrupted any number of times by urgencies I couldn't predict—in which to figure out an entire *Joy of Cooking* for a new planet, with new animals and brand-new plants. It didn't seem like enough time, but it never does. (And though it surprises 3V viewers no end, unless there are obvious danger flags up on a world, any Survivor's first assignment is that same *Joy of Cooking*—obvious when you think about it, but lots and lots of people don't think about it.)

But of course I hadn't even dreamed of the interruptions yet. The first one took seventeen hours out of my life.

I was in my (jiffy-built) house. This was a single-room log-cabin arrangement, with a working kitchen using local fluid treated so as to become H_2O with fewer trace elements, a working bathroom, same specs, and windows here and there made of nice unbreakable Glassex, and impervious, I had been told, to anything short of the end of the world. I was staring at a bunch of roots that looked a little like bulbous carrots and a little like deep-orange, helium-inflated corn, and wondering whether boiling or baking would be a good place to start. Late-afternoon sunlight, in what was this area's fall, was coming through the windows, and I was surrounded by the small-animal, and occasionally large-animal, noises of the local forest. I didn't actually take notes on all this at the time, though I made plenty later on, but noticing details I'm not really noticing is one of the things I do best.

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I had about decided on boiling, to start with—it takes less time, so if it doesn't work I haven't spent hours on it—and I stood up to find the pot I was going to put the damned things in.

Then I got up off the floor and watched the sunrise through my nice impervious Glassex windows.

I felt nothing. I mean, nothing that seemed connected to what had happened. In the first seconds I wasn't sure just what *had* happened, but it didn't take me long to figure it out: late afternoon, sunrise; standing up, lying down. The only difficulty was whether I'd been out for seventeen hours (the planet had a twenty-six hour day minus about a minute and a half) or for seventeen hours plus some multiple of twenty-six (less a minute and a half per twenty-six), and a quick check told me it had been seventeen.

There is such a thing as a body clock, very roughly: How hungry am I? and How stiff am I? and most of all How much do I need to take in some liquid, or to emit some liquid? Will give you a fair time check, at least in terms of multiples of twenty-six hours.

The noises outside were not noticeably different.

That bothered the hell out of me.

What got to me even more was that I had no idea *why* it bothered the hell out of me. I had no fixed notions about what Tree noises were like during an early morning, a late afternoon, or smack at noon on Christmas Day. I hadn't been on the damned world long enough for that. But the back of my head had filed something that appeared to mean: noises should not be the same at these two points in time.

I could not figure out what it had filed, but I was not about to ignore it.

Did the noises have something to do with the seventeen hours I hadn't been around for? Had they somehow caused the blackout? Were they in some way a response to the blackout?

I could go on for seventeen hours here and now, listing questions that might, or might not, have had useful answers. There is seldom any shortage of questions.

The one answer I did feel fairly sure of was the answer to the question: "Why am I still alive?" I was still alive because I had been nicely shut inside my jiffy-house log cabin when whatever-it-was had come and got me. If unconsciousness was usually the prelude to being eaten (or at least taste-tested), some damned animal was in a very frustrated state, because he'd been unable to take off my large, unwieldy shell and get at me. Whatever had got me, it was something the jiffy-built house wasn't impervious to, which was sad but in no way a complete surprise.

I spent some time sitting and staring out the window at the nice, peaceful-looking forest. Then I looked around, found the bulbous carrots (or helium-packed corn) on the floor near where I'd been, picked up the bunch, and found a pot to boil it in.

Boiled, the stuff tasted almost exactly like sawdust mixed with black pepper, not one of the tastes people eagerly seek. But fried, perhaps. . . .

I sighed, and went to the door of the cabin. Outside, there were a lot of

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bunches of this particular root. I could pick one up easily and try frying it.

I could also walk right into some patient animal, wondering if the Possible Food Thing was ever going to come out of its big shell.

Well, that was also what I got paid for, silly as it sounded. I put the bunch of boiled stuff in my left hand, a slug gun in my right—slug guns make lots of noise, and frighten away animals you weren't even aiming at—and opened the door with my deep-orange, bulbous left hand.

And nothing attacked me. Nothing even stood around looking disappointed.

Even the fairly ubiquitous small animals didn't seem to be around; perhaps they were being properly small-animal cautious about the big construction that hadn't been there the day before. It was, in fact, a thoroughly peaceful day in the forest. Any minute now and I would see Red Riding Hood starting off on her errand to Grandma Fricker's House, or Handel and Grizzle looking for an edible witch. The place felt like that, sort of fairy-tale, and though I couldn't have said why, it was, again, something I didn't ignore.

Feelings are not facts. Once in a while they're better; they show you where the facts are hiding.

Not just then, though.

I walked slowly away from my cabin—having remembered to shut the door, which self-locked and was keyed both to the palm of my hand and to the pore pattern of the tip of my tongue. (My suggestion—just in case I had to get in quickly, and had my hands occupied or missing.)

I tossed the boiled bunch of stuff away to my right, and I took seven steps. A patch of the same stuff was another three or four steps ahead of me.

Before I could take step eight I heard a very odd sound indeed; it almost wasn't a sound. It was the faint echo of bacon sizzling somewhere on another planet.

The back of my head said, instantly: *Beamer*. I dropped flat on the ground, which at that point was covered with a sort of grass which looked, and felt, as if it had been made of pale yellow plastic buttons, several hundred of which dug the hell into me.

My head replayed the sound, and checked for direction. I had the impression it had been off to my left, and some distance away, whatever it had been; certainly the damned planet hadn't evolved beamers to shoot at strangers with, so there must be some animal or plant which made a noise like a. . . .

I was looking off to my left from my prone position, and there it was, a patch of button-grass burned nicely black, just as if by a beamer. About ten feet in front of my nose.

OK, I remember thinking with some irritation: who's not playing fair out here? Who has come to this brand-new world with an old beamer?

And why, for God's sake?

That was a question that had any number of possible answers. The least plausible was that some competing person or persons was trying to be a

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Survivor and underbid me for the job. There was no way I could make real sense out of that one; but ideas that began with: "Someone wanted a planet that wasn't yet inhabited, and that wouldn't kill him on the spot—for some purpose or other," sounded a little more as if they could be heading for plausibility.

But a) Why was this someone shooting at me? and b) Where the hell was he, so I could shoot at him?

The answer to the first question isn't: "Because he wants me dead." The right answer has to tell me why, on a continent the size of some small planets, this fellow is within shooting range of me. Why is he not five thousand miles away doing whatever it is he's planned on doing?

The answer to the second question sounded as if it might be simpler to find.

Off to my left. Within range of the burned button-grass. I tried looking without moving, getting a view out of the corner of my eye. There was a little wind blowing, and button-grass was moving slowly and unwillingly. I looked for any motion against the wind, and in a minute or so I saw some. I fired the slug gun without taking the time to notice that I was aiming it.

About seventeen animals screamed and panicked, all of them out of my line of sight and well into the trees. There was a lot of trampling, trumpeting, and pushing and shoving out there as everything tried to get out of the way of whatever had just made all that noise.

A slug gun will frighten animals you weren't even aiming at. It will also cover a retreat by a human being—and just by the way, why was I assuming the being with the beamer was human?—who had missed with his first shot, but, all in all, not by very much.

Question three: Is he going to stop, turn, aim, and try for me again?

Answer: Those seventeen fleeing animals are still fleeing, and making the hell of a racket in the process. A calm, cool, collected fellow might just manage to stop, turn and aim in the face of a small stampede of unfamiliar animals, but he'd have to be a good bit better than I am to do it well.

If there are hand-weapon users a good bit better than I am, they belong to a club I have never heard of. I stood up, and I didn't get shot at.

Slowly the screaming, trumpeting, trampling and so on faded into the distance. The normal sounds of the forest resumed, hesitatingly at first. I walked the remaining four steps, picked up a new fistful of bulbous orange whatevers, and took them back to my log cabin for frying.

Or possibly roasting.

Much later that day, it turned out that if you mashed the stuff into a pulp, and then removed the bits of husk or skin or whatever it was that held the globs of orange stuff together, you had something that would fry up pretty well, with an interesting taste of peppered cod. If you left the husk in the mix you had a sort of highly spiced glue, but with a little work a strainer would separate the bits out fairly well.

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Recipe #1 for the joy of Tree's cooking. I had spent a profitable day.

And I had spent a good deal of it—while working away in my kitchen area—wondering about my invisible assassin. There wasn't much I could do about him actively (and "him" is of course a term of pure convenience; the term I actually used is not printable, so "him" will have to do for now), but maybe I could figure out a) what he thought he was doing, b) why he thought he was doing it, and c) where I could make an appointment with him to discuss a) and b).

His having arrived near me might, after all, have been pure coincidence. If that were the case, maybe he'd just shot at me out of panic—not expecting another drop-in anywhere near his own site. It's easy to kick coincidence out of your thinking, but it isn't bright; coincidences happen.

All the same, this seemed a coincidence the size of the damned continent, possibly the size of Tree itself. I filed it as a small possibility, and went on to wondering about other possibilities.

First: let's suppose he wanted the planet to himself, and had to get rid of any intruders as rapidly as possible—had to cancel me out as soon as I turned up.

This seemed to require, at first, that he know about my arrival and landing, hurry to my landing area, and wait for me to emerge from my cabin.

Possible, again, but very, very unlikely; to know about my landing and to arrive that fast through quite a lot of Tree jungle, he'd have to have tracked my ship down somehow—in which case he'd have been able to arrive *when* I did, and he'd have shot at me before the jiffy-built cabin got jiffy-built. Why wait till the last minute?

But maybe, instead, he had detected the cabin being built, or some other sign of my arrival, just that little bit later. For all I knew the behavior of animals or trees gave him a clue; it was perfectly possible that he knew the place better than I did then and there.

So he arrived as rapidly as he could, set up, and fired at me as soon as I came out.

Because he wanted the planet to himself. Because he needed the planet to himself. Because he hated me, Gerald Knave, Survivor, from some little adventure somewhere else, or from some previous lifetime. Because he enjoyed hunting, and hunting people was better sport than hunting orange bulbous vegetables, or even strange Tree animals, even if you limited yourself to the somewhat rare large types.

Because. . . .

It was becoming obvious that I did not have the materials I was going to need to think with, and I was going to have to get some more materials somewhere.

It was going to interfere with my *Joy of Cooking*, but that was something I'd expected. Interrupted by urgencies I couldn't predict . . . hadn't I said that?

Well, I certainly hadn't predicted an anonymous damned fool with a beamer. Who the hell would have?

The way to collect more facts, of course, was to make myself a target.

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But this is a job that really ought to be done with great care; I planned to be a target with a safe, well-protected bull's-eye.

So.

I dug into my bag of tricks, feeling lucky that large animals usually call for a bit more in the way of equipment, all in all, than simply large guns. By the next morning I was about as ready as I was going to get.

I walked out into the little clearing around my log cabin—still no small animals, which seemed normal by then—and looked for food. *Joy of Cooking* still had to be put together, and it only made sense to start with the easy foods to get at—vegetables. Meat, which has to be run after and caught, could come a little later.

The bulbous orange things were, if not a solved problem, at least one recipe ahead of the rest. I looked around me, and found some large, tan buttons scattered among the pale-yellow ones that seemed to serve as a sort of grass, or ground cover, or icing on the planet's dirt. These, I had been assured, were edible (in the largest sense: they would not quickly poison anybody), and though they looked somewhat tough, it might be that they were even edible raw. I grabbed up several handfuls, not moving quickly and not trying to move slowly, just ambling along in a thoughtful manner, as if I were doing my job while trying to remember the name of the Comity Vice-Assistant's Assistant in Charge of Overcharging.

I wasn't whistling, or humming, but I tried hard to look as if that was my basic mood. Given that I had been shot at the previous day, it would have been an insane mood for me to be in, but it's interesting, in a way, to realize just how many people will cheerfully accept anybody's insanity except their own.

I'd collected about as many Tender Buttons (copyright Gtde Stein, back before the Clean Slate War, though as far as I know she'd never been off-planet) as I could comfortably carry, and I ambled slowly back to my log cabin with the load, trying not to look either disappointed or expectant.

Six or seven steps from my door, I heard that teeny sizzle again, and dropped flat on another damned patch of pale yellow button grass. The stuff dug into me just as uncomfortably as before—this was a continent, or at least an area, where rolling around on the greensward, or yellowsward, was never going to be wildly popular—and this time he was shooting low and to his left. He was also, judging from the sound, shooting a different size and make of beamer, God alone knew why.

A sizable patch of buttons had turned dead-black, over there to my right; much larger beamer, check. I stayed flat, tracking back as well as I could out of the corner of my eye.

Much less wind today. No button movement.

Ten seconds of dead silence.

Buttons moving over there, just to my left. Some sort of bird, animal or waterfall gave a scream like a duchess whose feet were being stepped on by several unruly commoners. The buttons stopped moving, and then resumed, a little more slowly.

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I had my own beamer in my left hand—frightening animals was not what I was after; stampedes were contraindicated—and I shot at the moving buttons before I could spend any time on aiming or shifting position. There was a small, rather odd-sounding *thunk,* and the whole damned area went up in flames.

Not a forest fire. Not even a button-grass fire.

I watched a rocket—a very small rocket—take off from the patch of button-grass, head for the sky, arc over toward the forest and away from my log cabin, and sizzle right on out of sight.

A rocket?

A rocket?

All right. He'd been hiding in a hollow, the button-grass giving the hollow sufficient cover; there'd been more of him than flat ground-level would have allowed. I would check on the hollow in a few seconds. I would check very damned carefully on the hollow. Later on I would scream and curse and otherwise blow off some steam, while trying to fit together some of the goddamnedest pieces, claiming to be one puzzle, I had ever seen.

First, I was going to spend several lengthy seconds in adjusting.

Yes, I know: this is not supposed to be necessary. We Survivors adjust instantly to anything, with our beamers at the ready and our laconic swaggers unholstered and to hand.

In real life, however. . . .

A rocket?

* * *

Whatever I had thought up to that point became instantly subject to massive revision. While revising, I got up and walked over to where the hollow had to be, and found out that it was there.

It had been dug, very carefully and very smoothly, by some sort of machine; human beings dig raggedly, and this was as smooth a post-hole as I have ever seen. It was about seven feet deep, and about three feet in diameter, and the dirt of Tree, at the bottom of the hole, was burnt to a sort of slag that looked like a fifty-fifty combination of glass and glue. The sides were glass-smooth, with two little indentations running at opposite sides of the cylindrical hole, top to bottom.

The rocket, obviously, had dug the damned hole during the night, and waited partway inside it, its beamer itching with readiness, until I'd come out in the morning. The thing seemed too small to have a human pilot, and I hadn't really offended any teeny races over the years. Obviously, I'd run into a rocket that hated me.

That conclusion didn't make a great deal of sense, but then, at the moment, I wasn't *making* a great deal of sense. Inside, where it didn't show (so the flora and fauna of Tree could go on appreciating my laconic swagger, I suppose), I was jumping up and down and screaming.

I'd marked the direction the rocket had taken, and I realized that I was going to have to go on being a target for a while. A fully generated protective field is an uncomfortable sort of thing to have to walk around in—sweat col-

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lects; despite the manufacturers' claims about blowers and cycling temperatures, sweat collects—but I was going to have to walk around in it for at least some of this new day. Inside the field, little could damage me except poison gas, and so far I had no evidence of poison gas anywhere in the picture.

That, like damned near everything else, was of course subject to change at any second.

Being a target cheerfully collecting vegetables wasn't going to work twice; there is a limit to just how insane people (let alone vengeful rockets) will believe you are likely to be. But a vengeful *target* would be almost plausible, I thought, and as I went back to my log cabin to collect some heavier weaponry I was screwing my face up to look vengeful, just for practice.

Once inside the log cabin, though, I relaxed the muscles. I got ready and collected some fairly heavy armament, suitable for carrying, together with some fancy instrumentation, and piled all of it near the door; then I went for the detail maps.

The forests got in the way a little, but not nearly as much as you'd think; drones can collect large piles of bare scientific facts, even when the area involved is not as bare as would be really helpful. The map showed me very few places where a miniature rocket might land without instantly setting a forest, or at least a large glade, on fire, and I translated those into the ground I'd seen, worked out the directions and came up, to my complete surprise, with only a single really hopeful-looking candidate.

All this was assuming, of course, that the damned thing had landed somewhere nearby, somewhere I could get to on foot. For all I really knew, it had traveled five thousand miles to its home base, which was somewhere under the ice of the polar ocean with Captain Nemo and the crew of Old Ironsides.

But the rocket did seem to be marked Local; why jump across continents yesterday if you were planning on coming right back today and doing more shooting? Commuting is definitely the hard way to arrange to murder somebody.

I mused about remote control for a minute. That seemed even more unlikely; the controls necessary would be complicated, leaving little time for actual aiming and shooting. All the same, if there had been someone inside the rocket he'd been a very small someone, and—it occurred to me—perfectly relaxed about getting his feet heated. Of course, there were protective fields . . . in fact, I was still wearing one.

Which showed me how completely I had been upset. I took the damned thing off, wiped myself down, thought about a fast shower in the almost-water my shower was geared to provide, and sighed. Then I put the field back on, grabbed up my weaponry and instruments, and started out on foot for Rocket Central.

I kept my eyes open for vegetables most of the trip, in an abstracted sort of way; the fact that I was doing that, more or less on automatic, cheered

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me when I noticed it, because it meant that the back of my head had figured there was a fair chance of my returning. Why waste time on a census of vegetables you were never going to get to cook?

It was a nice, normal sort of trek, in fact, barely two miles. Fall was rather hot in this particular area of Tree, or else the manufacturers were lying even more than usual about the protective field, but what's a little sweat between friends? I slogged through a glade or two, and the yellow-tan trees rustled gently in the wind, waving a little stiffly and being nourished by all the small furry animals that happened by. Flyers, a very few of the animals were—I had no idea how flyers made fur do for feathers on Tree, though I admit it's an interesting question; in fact, it might have been the most interesting question for me to answer while I was on the planet. At the time, of course, I was silly enough to believe that I was otherwise involved.

Rocket Central—a clearing among several glades—was a quarter of a mile ahead when I stopped, sat down with a carefully inaudible sigh of relief, and began to put some of the weaponry in order. There is a great deal to be said for weapons not marked Some Assembly Required, but if you have to carry the damned things before use, you may not have many options. I owned a medium-range beamer assembly, complete with sights so complicated they were almost useless, and a bomb-thrower our ancestors would have called a Bazooka, though why a bomb-thrower would be named for a chewing-gum I have never really figured out.

The beamer sights were good for one thing without being hooked up: they could tell me if there was a rocket in residence a quarter of a mile away. The damned thing had to be hot, even after the hour or so it had been waiting, and it certainly wasn't made of the same things as the trees, animals or dirt of the planet. Not unless Tree was much, much stranger than the drones had been telling me.

I set the sights up (a five-minute job, and I wonder whether anybody, at any time, has needed to use a medium-range beamer assembly, and has actually had the five minutes to set up its sights properly) and took one peek, and there it was, sitting in its clearing as if it had never even thought of flying over and trying to pot me. It had an innocent look hung on its nose, and I wanted very badly to rush out and paste it one.

Instead, I set up the Bazooka, aimed it very carefully, and fired. There was a hell of a noise, the Bazooka went backward about four inches in hard ground, and a smoking arc went through the edge of my glade and landed at the far edge of Rocket Central, maybe fifteen feet from the rocket.

I worried for a second that I'd cut it too fine, and damaged the damned thing, but it was a strong, spirited little rocket. It swayed a little on the ground, and then, when the explosion had come and gone, it started moving.

It didn't rise up in the air. It just started turning, fairly rapidly, as if it were trying to screw itself into the dirt. What it was doing, I saw, was

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hunting for the vengeful fellow who had tried to shoot it.

I wasn't, of course, hard to find. The rocket homed in on me, stopped its turning slowly, came round about eight more degrees, and opened a port up near the nose. The barrel of something or other poked a little way through the port, and wavered up and down for a second or two.

Then it fired. It missed the Bazooka by about two feet, because I had been crouched just about two feet from it.

By the time the shot arrived, I was three feet the other side of my weapon. I watched the ammunition expend itself against a yellow-tan tree, one of the bigger ones, and the tree didn't explode; it just sighed and disappeared. Apparently it had become impalpable dust, carried away by the air.

An extremely nasty rocket. I could have crouched where I'd been and let the beam or whatever it was bounce off me, but there's such a thing as boasting. Better, anyhow, to have the damned thing miss me; that way it would keep on trying, and I would find out a bit more.

I had most of my instrumentation trained on the rocket by then, and it was reading out heat changes, attitude changes, composition of rocket, a variety of interior scans of the thing, and so on. The rocket, having missed with its first shot, took a second, and this time it hit the Bazooka, which collapsed almost as fast as the tree had disappeared. It had been shredded.

The Bazooka had not been made out of Tree-wood. The rocket was shooting large bundles of very small circular saws, as I could tell from the tinkly clatter of their landing, and a few slow-motion bounces here and there—and the teeth on those blades were something very powerful indeed.

My readouts, meanwhile, were telling me something I did not want to believe. There really was some sort of being inside that rocket.

Second by second, the interior readout refined itself. The being inside of it looked human: two arms, two legs, head, torso, all in what seemed normal proportion. I began to wonder just how detailed the scan could get, and as the figure in the rocket—a figure small enough to move around a little in there, despite all the machinery!—got more and more human I switched the readout a bit to focus in on the head and shoulders.

Maybe I would recognize the fellow.

Maybe, on the other hand, it would turn out to be Little Red Riding Hood. Or Captain Nemo.

The rocket fired once more, missing everything except the air above the shredded Bazooka. Then it cleared its throat, the gun disappeared and the port closed, and another port, further down on the rocket, opened. This time what came out was a puff of black smoke.

Poison gas?

The smoke rolled slowly toward me just at the level of the button-grass, which turned an instant deep brown and seemed to go limp.

I did not hesitate. I got up, abandoning my heavy weaponry and some

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of the instruments, and ran like a frightened deer. I didn't think I had much of a chance, but I wasn't stopping to assess odds, I was running, and running took all my attention.

Pretty soon I was in a forest instead of a glade, puffing and blowing—and covered with sweat—and the black smoke was nowhere to be seen. Apparently, I told myself, it had a nice short lifetime, dissipating or somehow mixing with Tree's air pretty quickly. Or else it had just used itself up on button-grass, small animals, and anything else available.

I was, apparently, safe once more, and on my way back to the comforts of my log cabin.

I was also on my way to do some very hard thinking, because I had seen the face of the rocket's operator, if that's what he was, very plainly in those final two or three seconds.

I'd recognized him, all right. He was Gerald Knave, Survivor—but (if you remember the old, old joke) quite a bit smaller.

2.

Very well: I was dreaming. Soon I would wake up in my Key West Cabin, to find out that all the limes were dead. Or I would wake up somewhere else, to find out that my entire life had been a dream, and that I was, perhaps, eight years old.

Or, of course, not.

It began to occur to me, as I made my way back to my log cabin, that somebody really hated me. Somebody wanted me dead, and was doing a very earnest job of making wishes come true. How this involved a miniature Gerald Knave I had no idea, but that had to be a necessary piece of the puzzle; nobody would add it in as an afterthought, especially since the miniature was, under normal circumstances, invisible to its target.

No, there had to be a very good reason for the miniature to be Gerald Knave's miniature. My only thought at that moment, as I opened the log cabin door and more or less fell inside, shutting and sealing the door as I fell, was a brief one, labeled sympathetic magic.

The miniature, in other words, was some sort of doll or copy of me, meant to do me very special harm because it had my qualities. Someone had stolen bits of my skin or hair or fingernails, and used the bits in making the miniature, and that gave the miniature some sort of creepy and uncanny power over me (perhaps only over my remaining skin, hair or fingernails, to be sure).

There were actually people who believed that sort of thing, back not too many centuries. I'm sure that there are people somewhere in the Comity who still believe it, because there are always people, somewhere, who will believe anything you can even vaguely imagine, and forty or fifty things you'd have sworn you couldn't. Mother Nature does indeed get exceptionally weird now and then, but she is not even a patch on human nature, after all.

The trouble with feeling superior to the sympathetic magic people was that, while I truly didn't want to add sympathetic m. to my own little library of possibilities, I didn't have

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anything else around that seemed any more plausible.

I would cheerfully have settled for the whole thing being a dream, if that could have made any difference. But if it was a dream, I was stuck living in it, and if I was living in it I had to act, and respond, just as if it were real. And if, of course, it wasn't a dream . . . well, then, it had to have some sort of explanation tied to it somewhere.

I couldn't imagine one—but that, damn it, was my trouble, and not something I could blame on the events.

I sat in a chair in my log cabin, staring at the Glassex windows and deciding to settle for rations for a noon meal—a Survivor does bring such things along for the early going, when *Joy of Cooking* is only a page or so long—and trying the various pieces for fit: a rocket, a miniature me, a series of pretty good tries at killing the normal-sized me, and a planet with the hell of a lot of trees.

After a minute of thinking I was forgetting something, I brought back the feeling that the noises outside should have changed from late afternoon to fairly early morning. I couldn't make that piece fit anywhere; but it was not thereby a unique piece. I couldn't make any of the pieces fit any damned thing at all.

After a while I gave up and ate lunch. It was, as it always is after some crowded action, vaguely surprising that it was lunch time instead of, say, dinner time three days into the future.

Vague surprise was almost a pleasant, reassuring feeling by that time.

* * *

After lunch, I went out to pick tan buttons. There wasn't really anything else to do at the moment; I was going to have to rig something to prevent Thumbelina, as I'd decided to call the rocket, from shooting at me every so often, but that wasn't going to be too difficult; my supplies had been chosen with large, unfriendly animals in mind, and a rather small, murderous rocket looked like something the supplies would handle.

I wasn't about to go to war with it. I had a job, I had a year to do it in, and that left very little spare time for fooling around with this off-planetary hazard. I might be curious, and my bump of curiosity, if you'll forgive the Classical allusion, is more like Olympus Mons than like, say, the small pimple most people seem to have for the function—but I was just going to have to sacrifice my feelings and get on with the job.

So, over that day and part of the next, I sank some warning flashers, rigged to small explosives. I made a nice perimeter around the log cabin, big enough so that it included a fair number of vegetable patches of various sorts (there were some nice-looking tubers, for which I had high hopes, but the first few varieties were major disappointments, wet, ragged and tasteless or worse no matter what I tried)—and distant enough so that the explosives wouldn't jar me or the log cabin if they did go off.

I had every confidence that they wouldn't go off; the rocket, when I got a chance to see some of the readouts (and collect some more; the rocket hadn't come back for them,

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and, very cautiously and in full field, I recovered most of the dropped valuables myself early next morning) it became clear that the damned thing had detectors to spare, detectors to rent out, detectors to sell to the natives. It was going to spot my perimeter long before it had to deal with it, and it was going to stay nicely out of range.

Until, of course, it figured out its next move. I thought I knew what that had to be, and took the indicated precautions.

Then I went back to *Joy of Cooking*, chapter on tubers.

I won't bother you with most of the *Joy of Cooking*, since you're not going to be able to use the Tree volume, and while cookbooks make fascinating bedtime reading for some of us, there are a lot of people who simply aren't going to care about recipes they'll never try out. There are even, sad as it seems, some people who just don't cook.

I did try a lot of tubers, being very fond of tubers myself, but the first four varieties, as I've said, wouldn't come up to real edibility.

And it was a full three days before Thumbelina decided to try again; I was trying a fifth brand of tuber that day, along with some vaguely violet climbing vines that seemed to be filled with a combination of gas and seeds.

In those three days I had done some hard thinking, and I'd managed to get a little closer to the idea of Teeny Knave. If it looks like a duck, walks like a duck, and quacks like a duck, it may yet be a particularly persuasive wind-up toy, and it had begun to dawn on me that the figure I'd seen wasn't necessarily a living being, in the usual sense of the word. (Are robots—Totums, Robbies, robots of all sorts—living beings? It depends on how you define every word in that question, and what that means is that there is no general agreement on the subject, definitions being as individual as they are. It is always safer, however, to treat any unknown as if it were alive, from your Totum to your toothbrush.)

A robot built to look like me didn't make a lot more sense than a Teeny Living Sympathetically Magical Me (and made even less sense when I looked at some of the chemical-composition readouts), but the thought was, for reasons I hope are obvious, a lot easier to live with.

Somebody—human or otherwise—had built a robot to kill me with, and had, for reasons I had to insist were important, built it so it looked enough like me for me to recognize. (There might have been a clue in there; the robot didn't necessarily look like me to an impartial observer, if there is one anywhere in the Universe; what I recognize as me is what I happen to think looks like me in what I happen to see as important details. People you insist look alike aren't at all likely to agree with you; their list of important details is a different list.)

Well, on the third day, Thumbelina came flying over my log cabin, fully intending to drop in.

To drop in, that is to say, a small bomb.

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As I've said, I'd taken the indicated precautions—the thing was obviously going to avoid a ground approach, and that left flying or burrowing, and I couldn't really picture the rocket making its way to me like a nematode—and when it noticed that I'd rigged a blasting cannon (a fairly small one, but a small cannon is a hell of a big weapon) to cover the rooftop, it went sadly away again without anything in the way of a real try.

Smart rocket. Just smart enough so that I started worrying, at once, about its next try. Intelligence is a welcome quality in your friends, in your enemies, it's only half welcome; there are things you know an intelligent enemy won't bother to try, which is helpful, but there are things he will bother to try that you haven't thought of yet—which is not.

All I knew for certain was that it hadn't given up. It never did seem the type for that, right on through to the end—though in fact I never saw it again.

The end, however, was some while coming. I worked away at *Joy of Cooking*, getting, over two crowded weeks, a fair listing of basic vegetable dishes, and starting to think about meats and fishes. I had some of the adventures a Survivor gets to expect—being chased by a three-legged horned beast, a fascinating cross between a rhinoceros and a wheelbarrow, for instance, or falling into a rapidly running stream of not-quite-water on a day when I hadn't been wearing any sort of protective field; the job requires leaving that stuff off whenever possible, naturally, as colonists aren't going to live in protective fields.

That fall led to several days of charting my temperature and reactions while I stayed firmly in the log cabin; exposure to the water wouldn't kill me, the drones had promised, but the only way to find out exactly and for certain how very small doses of oddities affect the human body is to let them affect the human body. A slight rise in temperature, and, believe it or not, two days of intermittent hiccups seemed to be about the worst of things, and even that set of reactions would calm down as more and more colonists arrived, and as the planet itself was slowly pushed into closer and closer approximations of the colonists' needs and wants; small-scale terraforming is what people normally do, everywhere and all the time.

I had no word of any kind from the rocket for those two weeks, and that worried me more than anything else, because I had to believe it was laying plans. If I'd been the rocket, I'd have been laying plans, and I thought of two or three notions that might very plausibly work, and never doubted that Thumbelina Himself was thinking of two or three more than that.

The final interruption, though, was the assault. "Unexpected" was turning out to be a fine word for Tree, with "damned nuisance" a close runner-up and winner of Miss Congeniality. They're all unexpected, sure, but Tree seemed to be leaning on the quality a little more than most new planets do.

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I can't call it a stampede, though it involved a good many Tree animals—large ones, all of them: the goo-spitting giraffe was among those present, as was the rhinobarrow—there were also, always at a distance, any number of furry birds. (Every time I saw the damned birds, and I saw them every damned day, I wondered about the substitution of what seemed fairly heavy fur for feathers, and the plain fact never did dawn on me, not from that direction.) The animals weren't running in a crazed fashion from A to as near Z as manageable.

They were running purposefully.

I'd gone to sleep crowned with success—one final tuber recipe had in fact panned out nicely, with a strong taste of both yam and, believe it or not, Key Lime pie when strained and baked; I felt several steps ahead of myself and very victorious indeed. And I awoke at dawn to a symphony of horrible noises. I hardly had to look out the window to know what was going on.

The noises were an expansion for full orchestra of the panicked trumpeting, screaming and thrashing I'd caused by shooting off a slug gun back near the start of all this. That much told me: Animals on the Run.

The noises were getting louder by the second, and that told me: Running Toward Me.

Well, I didn't think they could trample the log cabin, which was after all impervious, according to guarantee. Some animals would have their heads bashed in if they ran straight for the walls, and in seconds I wouldn't be able to see out my Glassex windows because they'd be covered with animal, but that was about the extent of the threat.

The animals were racing straight toward me—I did look out the window in time to see that much; there wasn't even a slight angle away from the cabin. And there were a lot of large animals, a lot of distant flying furry birds, a lot of everything. Fish were missing (there being no running stream up to the cabin), and Thumbelina was missing, but everyone else in the cast appeared to have accepted the invitation with pleasure.

And why did I think Thumbelina should have been there? Well, because the animals were headed straight toward me. . . .

A rhinobarrow smacked the Glassex with its horn and face, lost interest in the whole affair and tried to sink gracefully to the ground. It didn't get there, because a flying wedge of other animals—with a sort of bald tan spider the size of a gorilla in the lead—was also trying to get to, or through, the Glassex, and everybody was being held up, while unconscious, by everybody else. I stopped trying to see through my covered window, and went back to theory, while smacks and thumps were added in great quantities to the screaming and trumpeting and so on.

The animals were headed straight toward me.

Now, what would have pushed them into anything like that?

Some sort of reaction against a stranger . . . shared among various animals? A sort of jungle telepathy?

Well, telepathy was certainly possi-

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ble for some races. But I'd been on Tree for several weeks. Telepathy that took that long a time to make up its mind, so to speak, didn't seem worth even ten seconds of thought.

So something outside the animals had pushed the animals. . . .

Thumbelina?

It seemed a good first hypothesis.

And then something else dawned on me, and very, very slowly—as the trumpeting, crashing, thudding, and general hooraw continued—all the pieces began to fall into place. I remembered what I'd *really* forgotten—not the identity of the noises, but the damned seventeen hours. *I'd been unconscious for seventeen hours.* I'd barely thought about that since—which was itself a massive, major clue.

But that wasn't the biggest clue. The biggest clue was one simple sentence I had never so much as said to myself:

Nothing happened more than once.

A: I fell down, unconscious, for seventeen hours.

B: I was shot at by a beamer.

C: I was shot at by a different beamer.

D: I was shot at by a disintegration thingummy.

E: I was shot at with a load of teeny buzz-saws.

F: . . . And so on. And, goddamn it, so on.

I felt like kicking myself, and no wonder. I was, again, outwardly calm and inwardly screaming and jumping up and down. The animal assault was beginning to fade, just a bit; there were fewer trumpetings, and a lot less in the way of thuds, because animals were now running into each other at some distance from the actual log cabin; I appeared to have a sort of outer coating five or six beasts thick in places.

Not that it mattered. Not that any of it mattered.

Nothing happened more than once—and things began by putting me out cold for seventeen hours.

Furry birds.

A robot Knave. (Who resembled me by my own measurements.)

And (as I had had every chance to realize while checking myself out from a fall into almost-water) the only way to find out how teeny doses of things affect the human body is to let them affect the human body.

Well, I knew what the leaves on those damned trees exuded, didn't I? At least in an operational sort of way; whatever the composition, I knew what the stuff was meant to do, and what, in fact, it did do—and very, very well, too.

A totally unfamiliar animal is an immense threat. He may poison you; he may just taste terrible (or make everything else taste terrible, I suppose); he may decide to eat you.

Do you kill the animal? Probably not; you don't know that you *can* kill it, and you aren't quite sure how, in any case; it's rather large, as killable animals go around you.

You chase it away. And chasing it away will look, to the animal, like a series of serious attacks.

And when one "Shoo!" doesn't work, you try another. Why? Because that's the way your mind works, if a

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mind is what's controlling all this, and one of these days one of those "Shoo!"s is going to pay off. You have, after all, researched things carefully; you had seventeen hours to do that in.

Telepathy . . . well, telepathy had to be a part of the place, and the leaves that had primed me for it should have told me that, or the furry birds—long, long ago. If I hadn't been so preoccupied with trying to find *real* reasons for a robot Knave in a rocket. . . .

And, come to think of it, if I hadn't known how telepathy worked in human beings. I'd had some experience with it a few years before, when an indigenous telepathic race tried to take over a human colony on a new planet some damn fool Survivor had passed as safe.

In human beings, telepathy just takes over—the human mind and spirit seems to be erased, and no one has ever figured out how to bring it back, though there have been lots of tries and work is still, they tell me, ongoing.

But this was different—that chemical emitted by the leaves had to act as a sort of primer, allowing just enough telepathy to get inside a human mind without kicking the resident human out of it.

And the trees, or Tree itself—I have no idea which, and can't see that it makes any practical difference just now; I prefer to blame the damn trees, but that's nothing but preference—had done just that to me.

Outside, things were quieting down. A lot. I looked around, and discovered that I could see through my windows.

There were no animals crushed up against them. There were no animals anywhere that I could see.

There never had been.

I took a very deep breath. The fairy-tale feeling I'd had for the world. . . .

And the fact that the noises outside hadn't changed from afternoon to morning. The feeling was, I began to realize, that a tape had been repeating itself—which turns out to be at the least a pretty good metaphor. A tape, so to speak, of the animal life Tree saw no reason to risk.

The damned trees had handed me a world full of threats and danger and terror. If I were a smart Unfamiliar Animal, I'd leave real quick.

OK. I was a smart Unfamiliar Animal.

And I was going to have to persuade the Comity to be just as smart. I thought I could probably do that; right at the moment, the human race is not absolutely desperate for living space. That's a feeling that comes and goes as the decades wander by, and it's been going, really, since we started real expansion into the local stars. We could stand to write off one promising-looking planet, and Tree could go back to doing whatever it is it does when nobody's watching.

I wish to hell I knew what that might be.

I thought back to that nice tuber recipe, and the nice taste of Key Lime pie in there.

Well, of course.

Tree had hypnotized me into a few small successes with its recipes—how much had been real and how much imagined, I might never know—just to keep me headed toward whatever

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its latest assault was going to be. It wanted to scare me, not kill me, and it wanted me to believe that all its threats, from Thumbelina to the animal kingdom, were perfectly real. The seventeen hours had been real—and caused by some sort of telepathy primed by the trees.

But its methods hadn't worked. So it had holed up for a while, considered whatever it had learned about me in its study period, and decided it would quit kidding around and just *tell* me to get the hell off its face.

Meanwhile, it kept me occupied with recipes, some good, some bad. Stampeding had to be thought out carefully—Tree, planet of brotherly calm, wasn't at all used to that sort of thing. (And I don't really think it was all that bright. Furry birds? Teeny Knave? It had never had to be bright, I think, and it was improvising like crazy. Sometimes, like any improviser, it slipped a little.) And while it was planning, its target was thinking.

Very slowly, to be sure. It was all there in front of me—the sheer insanity of the pieces kept me from seeing the insanity of the whole, that was all. Teeny Knave—which my analysis actually saw, recorded, got small details about. . . .

And those furry birds. . . .

They're what bother me most. There is no way for fairly heavy fur to substitute for feathers, as far as I can figure out (and as far as a few other, more knowledgeable people I've asked can figure out)—but there they were.

The drone ships actually saw them.

Question, friends: What is there that can hypnotize analysis devices, recording devices, and a drone ship?

Just what *are* the trees on Tree?

They might, after all, be intelligent, if (of course—like us) no more intelligent than they have to be.

They might, for that matter, be the plaything, or early warning system, or by-product, of something else, maybe something much smarter—how would we know?

Offhand, the best hope I have is that we never get close enough to it to find out. ■

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Jerry Oltion

HOLIDAY SPIRITS

When your circumstances change, so do your ambitions—sometimes drastically!

Illustration by John Stevens

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It must have been just after Thanksgiving when I died. I hadn't paid much attention to the date at the time, being preoccupied with more primal concerns, but when Tilbey, my partner in our wraith-like afterlife, asked me what I wanted Santa to bring me for Christmas I suddenly remembered the season.

"A body," I answered immediately.

Tilbey laughed. His voice sounded thin and distant, like a ghost's voice should. That wasn't on purpose; it was a side-effect of the mass cancellation process. The stronger we wanted our interface with normal matter to be, the more energy it took, so we had adjusted the coupling constant as low as we could go and still manipulate our tools—which in free-fall was pretty low. That meant the energy-equivalent of our vocal chords didn't push very much air, so we couldn't make much sound when we talked. But it was enough to get the message across.

"A body?" Tilbey asked as he plugged a fiber-optic data line into the control computer we were installing onto the stardrive. The jury-rigged monstrosity (the stardrive, not the computer) took up nearly half of Tilbey's quarters, and most of it was electrical rather than optic, so we had wires and converters and light pipe running every which way. "What do you want a body for? It'd just cost you tons of fuel to move it around. And then you'd have to watch out all the time that you didn't damage it."

"Yeah," I said sarcastically, "I might get killed, and then where would I be?"

Tilbey hung his head. If he'd been capable of it he probably would have blushed, as well he might, considering it was his gadget that had killed me in the first place.

Well, OK, I fell into it when the ship made a course change, but he shouldn't have left it running.

Of course that same prototype stardrive was responsible for my persistence as a ghost *after* it electrocuted me, so I suppose I owed him one for that. I'd had a glimpse of the absolute blank emptiness that awaits spirits who aren't preserved as standing waves, and I knew I was far more fortunate than most fatal accident victims. But I still missed my body. I missed the simple things that came with it.

"I'd like to drink something again," I said.

Tilbey looked at me over the tangle of wires and blinking lights. "You probably could if we cranked it up far enough."

"Hoxworth would throw a fit," I said. The captain of the *Intrepid*, the Earth-Mars shuttle on which Tilbey and I were still nominally crew members, was still trying to make a profit on this run and he begrudged us every extra kilowatt we used.

"He probably would," Tilbey agreed. "But it would be a legitimate test. We could find out if our sense of taste still works, and if the matter we ingest would be assimilated into a new body. And what happens when we turn the power down again afterward." He sighed. "That's what I want for Christmas. Enough research money to figure out all the ramifications of this."

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I had no objection to that. There were so many things we didn't know about the stardrive. Tilbey had designed it to remove the mass—and thus the inertia—from an object so it could be accelerated to lightspeed without requiring enormous amounts of energy, but we had been caught up in its influence long before he had intended to try it on a person.

That was why we were installing the control computer. Now that we had become inadvertent test subjects, it could at least monitor what happened to us and help us diagnose any unexpected side effects. And hopefully reproduce them. If we were going to sell the notion of interstellar exploration by ghost to the taxpaying public, we needed a reliable piece of hardware to demonstrate. And we needed it soon. The *Intrepid* was making its final approach to Earth, and while Captain Hoxworth would probably let us stay on board while the crew unloaded our cargo and took on more for another Mars run, he had made it clear that he didn't want to carry us along for another round trip.

"Let's wait until we get our UN grant," I said. While I trusted Tilbey's engineering genius, he was still a klutz. I didn't want him fooling any more than necessary with the machine that kept me alive, at least not until we had a backup.

"Oh come on, where's your sense of—" he started to ask, but the intercom interrupted him.

"Hoxworth to Tilbey," the captain said.

"Here."

"Our deceleration burn into Earth orbit is coming up. How soon can you be ready for thrust?"

"Any time," Tilbey replied. "Want us to turn up the power now?" He winked at me and mouthed, *Go ahead. Get yourself something to drink.*

"No, we've still got ten minutes. Wait for my mark," Hoxworth said, predictably.

Even so, I went ahead and got a squeeze bulb of coffee from Tilbey's private stock. As long as we were going to crank up the interface anyway, I might as well try it. As it was I could just barely pick up the bulb and burst the heater pack inside it, and tearing open the nipple was beyond my present capability, but I took some encouragement from the sensation of heat that slowly spread through my hands. If I could feel it, maybe I could taste it, too.

I never got the chance to find out. When Captain Hoxworth called with the sixty second warning, Tilbey reached for the coupling constant knob to turn it up—but in his usual Tilbey fashion he bumped it with his thumb before he could get a good grip on it and nudged it the other way. The coffee bulb slipped through my fingers—literally—and floated toward the ventilator intake.

Tilbey tried to turn the knob the other way, but now his hands were just as insubstantial as mine.

"Wait!" I shouted toward the intercom, or tried to, but my attenuated vocal chords moved no air, either.

Tilbey looked at me with panic in his eyes. I could read his lips as he

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asked, "What can we do?"

We had maybe thirty seconds to come up with something. If we couldn't interact with matter well enough to push against the deck when it pushed against us, then the *Intrepid* would leave us behind when Hoxworth fired the engines. It had happened to Tilbey before, and we'd had a hell of a time finding him again, even in open space. Now, deep in Earth's gravity well and in the midst of restricted orbits and approach vectors, it could become nearly impossible.

When the coupling constant was this low, we had only one trick: we could short out electrical circuits. So I did the only thing I could do. I reached for the control knob, reached *into* it, right down to the potentiometer at the base of the shaft, and stuck my finger through the wires down inside.

There are two ways to wire a simple control circuit. The direct way, where more electricity means more of whatever you're controlling, or the indirect way, which in this case would mean that a short circuit would switch us off completely. Tilbey had always seemed to be a direct sort of guy, so I prayed that his wiring habits reflected his character—

—And in the next instant I screeched in pain as the control knob and my forefinger became one. For an instant I was as solid as a live person again, but the last joint of my finger had achieved that state inside the potentiometer.

Then the sudden surge tripped the circuit breaker, and I went where dreams go when you wake up.

I realize that Tilbey's stardrive has also answered a completely different conundrum that has interested humanity for millennia: namely, is there really some part of a person that continues on after death? The answer is obviously yes, or else there wouldn't be anything for the stardrive to stabilize, but I'm afraid theologians will still have plenty to debate after the Tilbey process becomes commonplace, for my own experience as a disembodied soul in the natural state shed absolutely no light on the condition. No tunnel of light, no enlightenment—no anything at all.

Not even time passed. I felt myself go away, and then I felt myself come back, but there must have been at least a couple minutes in between because when I returned to consciousness Captain Hoxworth was there beside me. He had evidently heard me scream, or noticed the power surge before the circuit breaker kicked out, and had come down to Tilbey's quarters to see what was wrong.

My finger was no longer inside the machine. My flinch had apparently moved me just enough, or my unenhanced self had moved while I was unconscious, but in either case I was free of pain again. I was also nearly insubstantial again.

So was Tilbey. He pantomimed turning up the coupling constant knob, and Captain Hoxworth finally obliged him. The short had evidently damaged it; we flickered in and out while he turned the knob, but we eventually settled down to a solid enough state to permit speech.

Hoxworth didn't mess around—

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not with a deceleration burn window rapidly closing on him. "Let's fix your little problem, gentlemen," he said, "and put this ship in orbit."

"We're ready now," Tilbey said sheepishly. "I think."

"You think."

"Well, just to be safe. . . . " Tilbey reached for the control knob, but I batted his hand aside and adjusted it upward myself. I held myself in place by a wall grip while I stamped on the deck with my feet. They didn't go through.

"Looks OK," I said to Hoxworth.

"Good. Now kindly don't do anything else until we can get you and this damned contraption off my ship." He kicked off through the doorway and disappeared up the central access shaft.

"Jeez," Tilbey said petulantly, "you'd think he'd be a little more excited about having humanity's first stardrive on board his ship."

I pulled myself down to Tilbey's bunk in preparation for boost. "Maybe if it worked better he would be," I said.

"For crying out loud, it's a prototype!" said Tilbey as he pulled himself down beside me. It was a one-man bunk, and I wasn't too thrilled to be sharing it with Tilbey, but you get used to close proximity on a spaceship. Besides, it would only be for a few minutes. As he wiggled in between me and the wall, Tilbey said, "There's all sorts of bugs to work out, but once we get some funding we'll fix 'em in no time."

"I don't know," I replied. "Having to commit suicide to use it is a pretty big bug."

He snorted. "To you, maybe. There are millions of would-be astronauts who would kill for the chance to explore another star system."

"Yeah, but would they kill *themselves?*"

He was still trying to think of a reply when the thrust hit. The bunk slapped up against us, and we sank down into it, but we did it the way people normally do. It was a long burn, but when it was over we were in Earth orbit. Back to the cradle of humanity, who would, we hoped, help us work out the bugs in Tilbey's invention.

We should have known better. Ghosts don't exist. Science is done in universities or multinational corporations. And advances in space flight technology happen at UNASA, the United Nation's umbrella organization for off-Earth matters. It took the appropriations committee less than five minutes of debate to dismiss our request for funding on the grounds that our project showed "little chance of success or of having significant practical applications in the unlikely event of success."

We got the word the day before Christmas. We were still on the *Intrepid,* holding down the fort while the captain and the rest of the crew went home for the holiday. We were nearly insubstantial again to conserve power, especially now that the ship was docked to the UN Orbital Freeport and Hoxworth had to pay extra for utilities. Besides, we had already done practically all the modifications we could afford to do to the engine.

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Those modifications included a holographic control panel that we could manipulate even in our most tenuous state, but we needed far more improvements than that if we were ever going to use it for its intended purpose.

"Hah, Merry Christmas," Tilbey said disgustedly when he finished reading UNASA's rejection letter. "Cheap bastards." He squinted at the signature at the bottom of the screen. "F. Davis Rigby III," he read aloud. "Committee Chairman."

The letter was dated just a few hours ago, and sent from the UN council offices right there on the station. I said, "I'm surprised they're working on Christmas Eve."

"Hah," Tilbey snorted. "They probably get a real charge out of dropping coal into as many stockings as they can today. Keep the rabble in their place, spread a little bah humbug." He stuck his finger through the holographic control to switch off the screen. "They didn't even ask for a demonstration."

He pushed himself away from the reader—a process more akin to swimming than to the usual free fall tap-and-bounce—and headed toward the wall that separated his quarters from the entertainment commons, but I stopped him before he could push on through.

"Wait a minute," I said. "So what if they didn't ask? Why don't we give them a demonstration anyway?"

"What for?" he asked.

"For spite, if nothing else," I said. "But maybe we can prove to them that we have something real here." I swished my hand through the wall just above the light switch, and the power flickered momentarily as I shorted out the wiring.

"We'll have to do better than that," Tilbey said, but I could already see wheels turning as he thought it over. "Hah!" he said at last. "The ghost of spaceflight future! Sure, let's blow their tiny little minds."

We set the coupling constant at mid-range, figuring that would give us enough substance to manipulate objects if they weren't too massive, but we could still push through walls if we got a run at them. I left the control computer hooked to our e-mail line just in case we needed to change the settings, but I didn't want to count on that working. First we would have to find a computer wherever we were, and then we would have to type in our instructions without shorting it out.

We found the council chamber easy enough—it was listed on the station map—but by the time we got there nobody but a janitor was left. He was an older guy, white-haired and thin as a stick, and on Earth he would probably have been too weak to even stand, but here in zero-g he was still able to hold down a job. So Tilbey's invention was impractical, was it? I thought. So was the space station when it was first proposed, but here was one old duffer who no doubt felt different now.

The meeting room had a great view: a whole wall of Plexiglas that looked straight out into space. The nightside of Earth filled about half the

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view, cities sparkling bright as stars.

Tilbey paid it no attention. "Come on," he said to me when he saw that the UN appropriations committee was gone, "we've got to find this Rigby guy." And he pushed past me into the council chamber, shouting, "Hey buddy!"

"No, wait!" I said, but it was too late. The janitor heard Tilbey's thin, reedy voice, turned his head, and his eyes nearly bugged out of his head when he saw two smoky apparitions drifting toward him. At least we'd had the good sense to come in through the open door.

It didn't matter. The janitor gasped for breath, then turned nearly as pale as we were. He looked down toward his chest, frowned, clutched at his breastbone as if he was trying to tear it loose, then he looked back at us with an expression of total bewilderment, said, "Uh oh," and went limp.

"Heart attack!" I shouted. "Damn it, Tilbey, you've scared him to death!" I rushed toward the janitor, who, attached to the floor by his Velcro shoes, swayed gently like a piece of seaweed in the ocean. I grabbed him by his shoulders and began CPR, using my knees to compress his chest the way they train you to do in freefall, but it was like trying to compress a cloud. My knees just sank in, and my hands slipped through his shoulders.

"Help me!" I yelled at Tilbey, and he went around to the other side and tried to help compress the guy's chest from behind, but it didn't work any better with two of us than with one.

"The coupling constant," I told him. "Find a computer and dial up our control panel, and give me a solid body."

He moved toward the conference table in the middle of the room, where glassy rectangles set in its wooden surface had to be monitors, but a moment later he said, "No good. They're password protected."

"Then call a medical team! This guy needs help."

But UN officials evidently carried their own phones, because there weren't any in the room, nor in the corridor outside. There was an unmarked intercom to somewhere—probably a page call—but nobody answered when Tilbey stuck his finger through the button and screamed, "Help!"

That left just the two of us and one dying janitor. And we had to do something quick, because his heart had been stopped for a couple of minutes now.

I had just one trick left. Gingerly, queasily, I reached inside his chest. I was substantial enough now to feel my way around, past the breastbone, through the ribs that stuck out to the side, over to the right of the lung, its air sacs like plastic packing bubbles—to the heart. It felt like a squishy potato with tubes sticking out the top. If I thought of it in those terms, I wouldn't freak out. Just wrap my fingers around the potato and squeeze.

I went right through it, of course. But at our stardrive's current power setting there was just enough resistance to move the heart muscle a little. And the heart works partly through electrical impulses, which I was shorting out like crazy the whole time my hand was inside it.

I felt it give a little squirm on its

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own, and I pulled away. Not too fast, or I could do more harm than good. I felt for a pulse in the janitor's neck, but found none, so went back inside his chest for another squeeze. His heart kicked again, and this time I felt it beat a couple more times on its own before it quit. Once more, and this time it took off. The janitor shuddered like a ship with a bad thruster, then gasped in a breath.

A few more breaths and he opened his eyes. And of course there I was, floating right there in front of him like the grim reaper himself, come to harvest his immortal soul.

This time he got out the scream that had eluded him the first time.

"Good, good," I told him. "Oxygenate that blood. Now take a deep breath and let it out again."

"Huh?" he asked. Apparently that wasn't what Death was supposed to say.

"You fainted," I told him. "Come on, breathe deep now."

"But . . . you. . . . "

"It's a long story. If you breathe for me, I'll bring you up to speed."

"Who—"

"Breathe." I had no idea how long this guy's ticker would keep going after the workout I'd given it. I turned to Tilbey. "Get some medical help here. I don't care how you do it, just get someone up here now."

He thought about it for a moment, then went back over to the conference table and waved his hands through the computer terminals, one after another. Sparks flew, and smoke curled around the remains. Then for good measure Tilbey did the same for the intercom. "There," he said. "That ought to bring someone on the run, and *they* can call a doctor."

Sure enough, within thirty seconds two security guards burst into the room. They bounced to a stop when they saw us, but a man who's had a heart attack elicits a near-universal response, even when he's flanked by two ghosts. Maybe especially then. One of the guards used his wrist phone to call for a med-team while the other covered us with his laser.

"All right, you two," he said to us, doing an admirable job of keeping the quaver out of his voice. "Start talking. Who are you, and what are you doing here?"

I let the janitor go and pushed slowly away, stopping myself against a chair back. "We're the Solar System's first interstellar astronauts," I told him. "And we're here to show the UN appropriations committee what we can do. But we wound up saving this guy's life instead." I conveniently neglected to mention why that had become necessary. The story would no doubt become clear soon enough.

"You don't look much like astronauts to me," the guard said.

"Watch this," Tilbey told him. He pushed off the wall toward the window, took a couple of swimming strokes to build up more velocity, and plowed right through the Plexiglas. He had to shove himself on through, but he remembered to keep a hand inside the glass so he wouldn't drift away. From outside the space station, in hard vacuum now, he grinned and waved at the guard. Then he pulled himself back inside and said, "Astro-

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nauts. We're going to Alpha Centauri if we can get the funding to miniaturize our stardrive. Wanna come along?"

The guard, it turned out, was more of a homebody. So was F. Davis Rigby III, we discovered when we finally got an audience with him. But the janitor—an ex-marine named Liam who'd flown sub-orbital fighters in the Australian war—was anything but. When he heard what had scared him nearly to death, and what had ultimately brought him back to life, he was all set to join our team and take off into the cosmos.

And Liam, it turned out, was an old war buddy of the appropriations committee chairman. If he wanted to throw himself behind this crazy project, then Rigby had no problem throwing a couple billion dollars of UN money into the pot to see that it worked out for him. That's politics.

"You, uh, you do realize that there's only one way we know of for sure to get to be like us?" I asked Liam.

He nodded. "So? I'm ninety years old. I hurt all over. If I don't go this way, I'll probably stroke out next week anyway. Or choke to death on a chicken bone in the cafeteria. What have I got to lose?"

When he put it that way, it was easy to see his point.

So Tilbey got his Christmas present. Within hours we were installed in our own lab right there on board the space station, with practically unlimited access to test equipment, state-of-the-art components to modify the stardrive with, and electricity to spare.

And I got my present, too. Now that we had the money to pay for the power, I spent the whole day with the coupling constant cranked all the way up. I've had at least a gallon of eggnog, every mug of it laced with a different brand of rum, to see what each one tastes like and what their effect might be on a ghost.

All in the interest of science, of course. ■

Editor's Note: This story is a sequel to "Unfinished Business" (October 1996) and "The Spectral Stardrive" (November 1996).

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Blameless in Abaddon, James Morrow, Harcourt Brace & Co., $24, 414 pp. (ISBN 0-15-188656-3).
Children of the Mind, Orson Scott Card, TOR, $23.95, 349 pp. (ISBN: 0-312-85395-3).
Brothers, Ben Bova, Bantam, $22.95, 435 pp. (ISBN: 0-553-09379-7).
The Galactic Gourmet, James White, TOR, $21.95, 288 pp. (ISBN: 0-312-86167-2).
The Infinite Sea, Jeffrey A. Carver, TOR, $ 23.95, 379 pp. (ISBN: 0-312-85609-1).
The Last Enemy, Barry B. Longyear, White Wolf, $19.99, 288 pp. (ISBN: 1-56504-859-8).
The Unicorn Sonata, Peter S. Beagle, Turner, $16.95, 160 pp. (ISBN: 1-57036-288-2).
Age of Wonders: Exploring the World of Science Fiction, David G. Hartwell, TOR, $15.95, 319 pp. (ISBN: 0-312-86235-0).
The Next 500 Years: Life in the Coming Millennium, Adrian Berry, W. H. Freeman, $22.95, 338 pp. (ISBN: 0-7167-3009-X).

Some people would rather let sleeping gods lie. James Morrow would rather put them on trial. He also, as I said when I reviewed *Towing Jehovah* in November 1994, is an inspired lunatic.

Towing Jehovah dealt with the discovery of the two-mile-long corpse of God Himself floating in the Atlantic and the Vatican-mounted mission to tow Him to an icy preservation chamber in the Arctic. If you take your religion seriously, Morrow was being quite sacrilegious and heretical. A very naughty fellow. But fun.

Now we have the sequel, **Blameless in Abaddon**. The Vatican has sold God to the Southern Baptists, who have installed him in Orlando, Florida, as the centerpiece of a theme park. There is apparently a bit of life left in the Old Boy yet, but not enough to settle the endless debate over whether He is dead, in a coma, or moved on, leaving His body behind like a mayfly's husk. Just in case, a gigantic heart-lung machine keeps His corpus ticking.

Now meet Martin Candle, a Justice of the Peace with a talent and a drive for justice. His wife dies in a freak accident. He himself comes down with a viciously recalcitrant prostate cancer. The World Court in The Hague

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announces that henceforth action may be brought before it against individuals. Candle decides that God, for all His supposed benignity, has permitted such a wealth of evil in His creation, that he should be brought to trial before the World Court. If found guilty, His plug should be pulled.

So far, so cute. But it turns serious. Morrow is here trading in a very classic genre, the theodicy. A great many theodicies—attempts to vindicate God in the face of the existence of evil—have been written since the dawn of the Christian Era. Morrow mentions many of them, recapitulates their arguments in defense of God, and attempts to shoot suitable holes in them. In the end, however, Morrow must turn to God Himself—or His Son, the Rabbi Yeshua—for an answer the Church has rejected as heresy many times.

One might think that an exposition of theological philosophy would grow tedious. Yet the prosecution's catalog of horrors grows tedious much more quickly; Morrow knows this; he has his characters say so; but Martin Candle and Morrow insist on laying out the endless indictment until the reader's mind and soul grow numb.

The issue Morrow is grappling with is both real and important. It is one most people hardly know exists; they have their beliefs and a comforting set of pat answers that kick in anytime reality gets awkward. I suspect Morrow is posing the issue in the hope of making people think a little more deeply. Perhaps he even hopes that people who think about the issue will come to the mathematician's answer: if two propositions, A and B, are mutually contradictory, then either A or B or both A and B are false.

Proposition A is, "God is good." Proposition B is, "Evil exists."

Think about it. If you need help, Morrow is an entertaining guide.

Orson Scott Card's *Ender's Game* (1985) and *Speaker for the Dead* (1986) won their author Hugos, Nebulas, great praise, and many readers with their portrayal of Andrew "Ender" Wiggin—forced as a child to master war games that were in truth actual battles against the alien buggers. He did well, and for a time it seemed that he had exterminated the buggers. But then he found one last bugger queen, nurtured her, invented the profession of speaking for the dead, traveled in time to the world of Lusitania, and released the bugger queen to reestablish her species. But Lusitania also held native sentients, the "piggies," and a "descolada" virus so threatening that the Starways Congress despatched a fleet to destroy Lusitania and all upon that world. *Xenocide* (1991) gave us Jane, a virtual intelligence that inhabits civilization's computers and the ftl links between them and can cut the destroying fleet off from contact with its masters, teleport spaceships full of piggies, people, and buggers to safe havens, and take Ender Outside the Universe to materialize younger avatars of his sister Valentine and late brother Peter (though both must be animated by his own "aiúa" or soul, since they have none of their own). On Lusitania a cure for the virus is sought and found. Civilization, at last aware of Jane, is shutting down

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its computers to kill her. The fleet is getting closer.

The fourth and last book in the series is **Children of the Mind**, which Card says was originally intended to be the second half of *Xenocide*. Its tasks are clear: to save Lusitania, piggies, buggers, and Jane, to stop the fleet, to give young Valentine and Peter aiúas that can sustain them even if Ender stops paying attention to them, to bring Ender's own tale to closure. In all of these, it succeeds. The reader is satisfied, perhaps in spite of the mysticism that pervades the tale (a psychic awareness of the gods, telepathy or "philotic" twining, teleportation, aiúas), definitely because of Card's immense skill at portraying character and because of Card's sense of connections among the forces that organize a culture. Much of the action here centers on the search by Peter and Si Wang-mu for the source of the sentiment that sent the destructive fleet on its way—not the Starways Congress, not the factions, not the philosophers behind the factions, not the teachers of those philosophers, but the spirit behind the teachers, and then where lies the voice of that spirit? And how can one—*can* one?—persuade it to change its mind?

Is it truly the last book in the series? Well, the cover *says* "fourth and final," but there is one large loose end remaining. The Lusitanians, as they seek out new worlds for their refugees, also seek the source of the descolada virus, the home of those who sent it forth to do its damage, and they find it. They also begin the process of trying to talk to these aliens, to decide whether they were potential friends or inevitable foes that must be destroyed. But *Children of the Mind* ends before anyone even meets these aliens in the flesh; there is clearly another story to be told.

If you have Internet access, visit http://www.tor.com/ to see the current catalog, coming attractions, and links to other pages, including two for Card.

Ben Bova's **Brothers** is an interesting study of the way scientific ideas can arouse a variety of passions, both among scientists and among others. The basic idea is the discovery of a way to command the cells of mature tissues (heart, muscle, bone, etc.) to return to an embryonic state, multiply, and remature, in the process forming anew organs that may need replacing (such as hearts or kidneys). Unfortunately, the process is not well controlled; it also causes cancer, though there may be a way to sidestep the problem.

The central characters are two brothers, Jesse and Arthur Marshak. Jesse, recipient of the Humanitarian of the Year Award, is a physician dedicated to the poor patients of a big-city medical center; he has also married his brother's fiancée. Arthur is a molecular biology researcher, head of a private lab developing techniques that have prompted him to think of regrowing nerves in paraplegics. He talked to Jesse, who said, "Organs!" Jesse then talked to a TV evangelist who said, "The Devil's work!" and proceeded to stir up assorted nutcases, ranging from a Jeremy Rifkin look-alike

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to the animal-rights commandoes.

Arthur is naïve. He believes that the issue of whether the work should be allowed to proceed should be settled on the scientific merits. He therefore goes along with the notion of a "science court," an adversarial proceeding, complete with a jury of his peers, and feels much aggrieved when the adversaries refuse to stick to the facts, bringing in the nutcases, the profit motive, the morality of developing a technology that will benefit the rich before the poor, the emotional ravings of a researcher who tried to solve her personal problems by prematurely trying the organ regeneration technique on herself, animal rights, and so on.

Does it seem rather fantastic that a technology with such obvious benefits would be controversial? I wish it were so, but recent history makes it clear that Western society is deeply skeptical of the benefits of technology (and never mind what that society is based upon). The actual fantasy here is the idea of a science court, which really was broached some years ago but was soon dropped, largely because—as I recall—adversary, court-like proceedings are much less suited to determining the facts of science (that is what experiments are for) than the interpretation or significance of the facts, precisely what Arthur Marshak wants to keep the court away from. Those who considered and dropped the idea may also have felt that a science court could too easily transform dispassionate science into passionate, melodramatic, media circus—precisely what Bova has used it for to bring his tale alive.

* * *

James White's latest Sector General novel is **The Galactic Gourmet**. For those who need reminding, Sector General is a vast interstellar, multispecies hospital whose potential for drama White has exploited for many years. In the process, he has given us a body of very readable, highly entertaining work almost uniquely free of the kind of military, political, and criminal conflict so common elsewhere.

Very much in White's pattern, *The Galactic Gourmet* begins as the famous chef Gurronsevas, a Tralthan (think of a six-legged rhinoceros) widely renowned for its expertise in multispecies cuisine, decides to go to Sector General. It has heard that the hospital food is rather uninspiring and feels that Sector General poses a challenge worthy of its talents.

Gurronsevas is not precisely welcome, but its talents do indeed make a difference. But then it makes a few very clumsy mistakes and is forced to hide out on the hospital's ambulance until things calm down. It is thus on board when the ambulance hies off to see what can be done for a world whose natives (kangaroos with teeth) are starving because of past technological pollution and population overrun. Of course, Gurronsevas's talents save the day—there's nothing like a good chef to make even a carnivore appreciate a salad—and after a certain misunderstanding about just what the ambulance crew is really doing with an injured local hunter is cleared up, it is very much appreciated all around.

Have fun.

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* * *

The third entry in Jeffrey A. Carver's "Chaos Cronicles" (after *Neptune Crossing* and *Strange Attractors*) is **The Infinite Sea**. The saga began when John Bandicut met an alien artifact on Triton, the "translator," which equipped him with a pair of translator stones, a resident alien, the quarx, and a mission, to save the Earth from an unsuspected runaway comet. John of course succeeded and promptly wound up on a humongous space station known as Shipworld, where he acquired several alien colleagues, solved a problem, and was shipped off once more, to splash into the present tale's infinite depths.

Why are they here? By now it is clear that Bandicut and his team are Shipworld's troubleshooters. Presumably there is trouble here, and very soon they have their first inklings. Deep in the sea is a city of newt-like aliens, the Neri. Still deeper is a mysterious destructive force, the Maw, which produces earthquakes and threatens the continued survival of both the Neri and the land-dwellers with whom they compete to salvage sunken ships.

All the members of Bandicut's team—the two now-sentient robots, Ik, Li-Jared, and the Thespi third-female Antares (whom Bandicut finds enticingly human despite certain oddities of figure)—prove essential to establishing communication with the Neri, figuring out what is going on, making peace with the land-dwellers, undoing damage done by the Maw, and finally solving the problem of the Maw itself. Along the way we meet a number of interesting aliens, all of good will (there is no evil here, only misunderstanding and lack of communication). We also learn that Shipworld is not the only major player on the galactic scene, that a human male and a Thespi third-female can get it on, that further adventures await, and that the translator on Triton is still active, talking to Bandicut's former girlfriend, Julie, equipping her with translator stones, and pitching hints that someone or something is out to destroy Earth.

The saga is by no means over, and it's looking better than ever since conspiracies make better sense than the ability to predict chaos. What comes next? It's hard to say, but one thing does seem likely: Julie and Bandicut will meet again, and when they do there will be some interesting emotional complications.

Barry B. Longyear's **The Last Enemy** nicely concludes the story begun in 1979, when "Enemy Mine" was first published. That tale won both the Hugo and the Nebula and was made into a movie, which was then novelized. In other words, it was popular. Its sequel, *The Tomorrow Testament,* came along in 1983. So it's been awhile.

Last Enemy is set many years after those earlier tales. The war between humans and Dracs is over everywhere but on Amadeen, where every ceasefire, every truce, is broken by renewed atrocities by one faction or another of one side or the other. As Barry says, the gun in play "was loaded on . . . the streets of Belfast and

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Sarajevo, and the deserts of the Middle East before either Timans, humans, or Dracs even knew there were stars to touch."

Timans? More aliens, of course, whose basic survival strategy is to set their foes against each other. They arranged the human-Drac war in the first place, though now, on Amadeen, first causes are quite forgotten. The war is now its own excuse, an endless cycle of reprisals.

Now meet Yazi Ro, Drac warrior on Amadeen, desperate slaughterer, face-to-face with a human woman who is fiercely protective of a Drac infant. The pain of war gets to him at last. He sets down his weapons and goes in search of peace. The search takes him off Amadeen to learn the story of the Timan plot, to meet Willis'Davidge and the descendants of that Drac warrior he had once confronted, to discover his own culture, to be faced with a plot that endeavours to keep the species apart and warring, and eventually to find a solution to the Amadeen problem. That solution—I dare not say too much—is familiar to parents who tell two warring siblings, "Cool it! The first one to move will get it!"

The tale is thus a very hopeful tale, but my cynical mind finds it too easy to imagine what would happen if Big Momma stepped into the Middle East or Belfast, Ireland, or . . . with such a message. Those warring sibs would join forces just long enough to remove the obstacle to their continued play. On the other hand, we've never yet had a Big Momma who truly refused to take sides, except in the sense that she refused to whack either playmate as it deserved. Maybe it would be worth trying.

This one's thoughtful and satisfying, and don't be surprised to see it on the award ballots.

Barry's publisher, White Wolf, is doing a number of other interesting things. It is reissuing James Gunn's classic anthology **The Road to Science Fiction** (Vol. 3, *From Heinlein to Here*, is $14.99, 529 pp., ISBN 1-56504-821-0). S. P. Somtow's fantasy **Riverrun Trilogy** ($14.99, 581 pp., ISBN 1-56504-843-8) adds the never-before-published *Yestern* to *Riverrun* (1991) and *Armorica* (1992). George Zebrowski's **The Sunspacers Trilogy** ($14.99, 394 pp., ISBN 1-56504-856-3) includes *Sunspacer* (1984), *The Stars Will Speak* (1985), and for the first time in book form *Behind the Stars* (1993). **Edgeworks 1** ($21.99, 399 + xxxiii pp. + index, ISBN 1-56504-960-8) is the first of twenty volumes of Harlan Ellison's collected works; it includes a new introduction and the previous books *Over the Edge* and *An Edge in My Voice*.

There are others as well, but I can't list them all (visit White Wolf at http://www.white-wolf.com/). Suffice it to say that the packages look quite nice: recycled paper and artwork with a generally serious (mainstream) feel even on the mass market titles. Here is science fiction taken as seriously as any publisher has ever done it. I expect to be very pleased when White Wolf brings out my own **Silicon Karma** later in 1997, and then my anthology **Gedanken Fictions: Stories on**

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Themes in Science, Technology, and Society, which I assembled to use in my course on the topic.

Peter S. Beagle's **The Unicorn Sonata** takes us back to the world of unicorns with the tale of Josephine "Joey" Rivera, who meets a strange boy, Indigo, who plays a wondrously enchanting music on a strange horn and then follows that music to a Border that admits her to the world of Shei'rah, where satyrs, water-nymphs, minidragons, and unicorns, the Eldest, romp among the flowers. Unfortunately, the Eldest—who are the music of the land—are for some mysterious reason going blind.

Joey is young, just a kid with a part-time job in a music store whose owner pays her in music lessons. Her grandmother, Abuelita, is in a nursing home. Indigo wants to move to our world and give up his horn. And all are needed to achieve an ending satisfactory to all.

A nice, heartwarming story, presumably to be helped by Robert Rodriguez's illustrations (not present in the "advance copies" given to reviewers) even though the cover makes one think the artist did not bother to read the story.

David G. Hartwell's **Age of Wonders: Exploring the World of Science Fiction**, first appeared in 1984. He has now revised that admirable survey of the nature and place of SF, updating many references and adding half a dozen appendices, including essays on hard SF, fantasy, and editing SF (in which he slips, saying he knows of no SF editor with a science degree; apparently, he never heard of Stan Schmidt), and lists of books important in SF's prehistory, best books since the 1920s, and readings for an SF course.

Hartwell may slip occasionally, but in no big way. He is a scholar of the field as well as a major editor, and he is well worth attending.

Don't waste your money on Adrian Berry's appalling **The Next 500 Years: Life in the Coming Millennium**. Berry begins by promoting the Gambler's Fallacy to the status of a basic principle of prophecy, saying that "if one waits long enough everything that can happen will happen." He then demonstrates shoddy scholarship by repeating the schoolchild myth that Columbus had to combat widespread belief in a flat Earth (as Stephen Jay Gould documented in his *Natural History* column for March 1994, the Earth had been known to be a sphere since classical times, and in the fifteenth century only a few cranks believed in a flat Earth). He displays a profound misunderstanding of science by claiming that because the Second Law of Thermodynamics requires the running down of a closed system, it requires the eventual end of each human life (a living thing is in no sense of the term a closed system). He says one can breathe a liquid mixture of carbon and fluorine (yes, I know he means a liquid fluorocarbon, but that's not what he says). He says that Edgar Rice Burroughs wrote *The Martian Chronicles*. There are a great many other problems as well. Indeed, the number of problems is so great that it is a surprise to see the name of

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a reputable publisher on the book; a vanity press would be more suitable.

That is, Berry would have benefited immensely from a knowledgeable editor. Given that, one could read his excessively brash technological optimism with some interest, although he is still not to be taken seriously as a futurist. The difficulty here is that he wears blinders: He refuses to admit the possibility that we face problems of any seriousness, pooh-poohing the idea of a population problem by quoting with approval the nonsense economist Julian Simon (who has said the more people, the better; there are no limits) and the threat of global warming by quoting with equal approval researchers who are funded by the fossil fuels industry (see Ross Gelbspan, "The Heat Is On," *Harper's Magazine*, December 1995). The paeans to the marvelous potentials of particular technologies which he quotes tend to predate the realizations of difficulties (e.g., the rapid terraforming of Mars; he really should have read Martyn Fogg's work; see the May 1996 column). And finally, he neglects areas of technology such as genetic engineering, which are likely to play a very major role over the next few hundred years. ■

If you're attacked from all sides, it's possible that you're doing something right; it's also possible that you are doing everything wrong.

—Adam Gopnik

Money is great stuff to have, but when it comes to the act of creation, the best thing is not to think of money too much. It constipates the whole process.

—Stephen King

Walk right out on the stage, and tell your tale to your audience, and perhaps many will believe it.

—Harry Houdini

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BRASS TACKS

Dear Dr. Schmidt:

Your insistence upon accuracy is one reason I love *Analog*. "The Content of Their Character" (June 1996) surprised me by hinging on an impossible situation. One difficulty with restoring sight to an individual born blind or who lost sight at an early age is getting the brain to interpret the visual data. Our hero would be overwhelmed by the information overload, as the story suggests. He would not, however, be able to recognize anything.

This problem was being discussed as long ago as the Victorian Age. Case study: a traumatic episode left a child hysterically blind. Years later her parents agreed to a new treatment—hypnotherapy. Dr. Mesmer helped the young woman overcome the initial trauma, and sight was restored. Unfortunately, she was traumatized anew as she struggled to make sense of the information flooding her brain. She could see, but failed to recognize people and objects until she closed her eyes against the frightening distraction of sight and resorted to the familiar information gathered by her other senses. Her brain restored order by again "refusing" the visual input.

More recently, experiments have been done with glasses that invert the field of vision. Because the eye only collects data, and the brain is the true "seeing" organ, after a few days of wearing the glasses, the image rights itself, so that the individual is restored to the "normal" mode of sight. If the glasses are then removed, the world looks upside-down because the brain is now doing an automatic invert to make sense of the incoming data. After a few days of this, the brain again restores order with a second inversion.

Numerous experiments with animals underline the point that the brain is selective in the data it processes. Miss the normal "window" of learning to interpret particular data and you've almost certainly lost the opportunity to ever interpret it correctly (read usefully—it could be argued that our interpretations of sensory input are grossly inefficient and often misleading). A case in point—the tracks in Arizona have an adoption program for greyhounds retired from racing. The dogs make excellent pets but they can't navigate stairs.

In his early teens my son was discovered to be essentially blind in one eye. Using both a contact lens and a regular lens, his vision was corrected to 20/30. He was terrified. The sudden addition of depth perception

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made him feel as if stationary objects were leaping out at him. He had learned to hit a baseball and sink a basket from anywhere on the court before we discovered his vision problem, but had tremendous difficulty doing so with his vision "corrected." He never did adjust and stopped wearing the lenses. We surmise that his brain had learned to calculate distances mathematically. He has since lettered in volleyball and has become an excellent driver. Apparently the "limited" input he receives is adequate. Anyone who'd care to argue can challenge him to a game of pool, wagering heavily on the outcome (he can use the money for college).

I've even seen movies using the phenomenon as part of the plot line, so it seems the difficulties involved have become general knowledge. Instead of spending months working on headgear to gain permanent sight and then chucking the project because he realized the flip side, Mr. Larsen's hero would be more likely to spend several months trying to make sense of the weird input and then giving up when he realized it was more trouble than it was worth. Of course, adherence to the facts would interfere with the point of the story, except. . . .

When I was eight years old, the mother of one of my friends told me I couldn't play with her daughter because I was the wrong color. I didn't know if I was wearing objectionable clothing or she found my freckles annoying. Eventually I figured out what she meant, but somehow my brain has never quite made the transition. Even now, I'm occasionally surprised hearing a remark about someone's "color." Not because I never noticed the particular shade of skin tone, but because my brain never became adept at categorizing along those lines (which is just fine with me, since the idea of deciding various browns are somehow "white" or "black" is illogical as well as irrelevant). Character has always bypassed the optic nerve (and every other sensory source of input) and lodged directly in the brain.

CARRIE MARTIN
26 Lincoln Avenue
Watervliet, NY 12189

The author replies. . . .

Carrie Martin raises some excellent points concerning the ability of the brain to process data supplied by the eyes.

She states that "the eye only collects data, and the brain is the true 'seeing' organ." I tend to agree, but here is the crux of our differences. The eyes collect and transmit data to the brain, which then processes the data. But—and here's the point—James wasn't using eyes. He was using a virtual reality helmet that was feeding data to his brain in a completely different way than his eyes would.

In a virtual reality program like Virtual Meadow, the digital software is far more organized than data supplied by the eye. Each item in the program—trees, clouds, deer, birds, flowers, and the meadow itself—has been deliberately programmed to appear as it does, differentiated from the other items in the program. It doesn't matter if James's brain has not learned how to distinguish these images—the

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software has done it for him.

In most cases, the eye is a passive recipient of data, and the brain is an active processor. But in this case, the software is the active processor, and the brain is a passive recipient.

This is the vital difference between James's experience and the experience of the test subjects in the studies cited by Ms. Martin. But I was pleased to note that, while she had technical objections, she caught and appreciated the real point of the story.

The story originated when I thought about how much power visual images have over our attitudes. Superficial things like weight, beauty, style of dress, and color of skin hold tremendous influence on our first impressions (which are often lasting impressions) of a person. So I created a character who would find out about these things last, and would discover the true value of people first—by how they acted and how they treated people.

As James pointed out, it's so obvious that a blind man could see it. It's the rest of us that can't seem to grasp the concept.

DOUG LARSEN

Dear *Analog*:

I haven't received my July issue yet—it takes some time for them to produce the Talking Book version—so I'd like to comment on something in the June issue instead.

I was very disappointed and actually somewhat upset after reading Doug Larsen's "The Content of Their Character." From a blind person's point of view I have to say that many things in the story are illogical or just plain wrong! The story seems to perpetuate some myths and stereotypes about blind people.

Probably the thing that bothered me the most was the "May I feel your face?" bit. Feeling another persons face seems to be an obligatory part of any story in which there are blind characters but in real life this just doesn't happen!

I was also concerned that the fairly young, blind characters in the story were living in a retirement residence. I hope that Mr. Larsen realizes that there is no reason why someone like Jim who seems very independent and well adjusted could not live on his own in a regular apartment.

James's reaction to being able to "see" also does not ring true. Like James in the story, I was born blind. I have no concept of what seeing is. If I were suddenly given a way to see I'm sure I'd be totally overwhelmed as James was. However, I doubt that I would be able to make any sense of the experience as quickly as James does in the story. The author seems to assume that James has some visual knowledge that someone who has been blind all his life could not possibly have.

Another minor point: Blind people generally do not navigate by counting paces. That's much too unreliable. My paces would never be the same as another person's and they could easily vary.

There were other things in the story, not related to blindness, that did not make much sense. For example, the scene at the end where James

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picks up a can of roach spray is wonderfully dramatic but why would that can be sitting there right next to the chess board? Seems pretty improbable to me!

I usually find *Analog*'s stories to be well thought out, accurate to detail and logical. "The Content of Their Character" could have used a bit more work.

HOWARD GOLDSTEIN

via the Internet.

The author replies. . . .

It's too bad that you read "The Content of Their Character" and completely missed the point of the story. Let me address your points one at a time.

When I interviewed a spokesman for a Society for the Blind, he said that Feeling Your Face was extremely rare, and used only in times of great intimacy. This description fits the incident in the story rather well. In fact, his phrasing is what inspired the tender, sensual moment I wrote. The fact that you personally don't do it is no fault of mine.

You mentioned the fact that I have them living in a retirement residence. Notice, however, that I never said that all blind people live in retirement communities. There is a difference. A friend of mine lives in a retirement community, and it's a delightful place where anyone who wants easy social contact, and doesn't want to cook for himself, would feel very welcome. And keep in mind that while I put them in a retirement community, I also portrayed them as educated, articulate, professional, affluent, loyal, creative, sensitive, well informed, brave, and perceptive.

As for how well James can "see," it is completely different from how it would be if you suddenly gained your sight. James's brain is a direct recipient of a sophisticated virtual reality computer program, in which every image is already meticulously defined and organized. If your eyes suddenly started working, your brain would have to be an active interpreter of the images it receives. But in James's case, the interpretation—in fact, all of the work—has already been done by the computer program. His brain is a passive recipient of data that has already been organized in a way that he can understand.

Regarding the point about the roach spray, I could have written something like: "I got up and walked over to the supply closet, opened the door, reached in to the far-right corner where I kept the roach spray, grabbed it, closed the closet door, turned around and pointed it at Kenny," but instead of it being dramatic, it's busy and boring. Besides, the location of the roach spray is not the point of the scene.

DOUG LARSEN

Dear *Analog*:

I read "The Content of Their Character" in the June 1996 issue. I have to say that story hit me like a bombshell. I came away laughing and crying simultaneously with joy.

I could not find a flaw, either in the reasoning or the storyline. I am blind, and I have had my sight for a short period during my blindness. It was as

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you wrote for James when he had his sight via the VR program after I got over trying to learn to see. And I have a talking computer. I could relate so well!

I am living in the South, and I am constantly faced with race relations. I want to scream with outrage quite often. As both Jims said, "What is black?" "What is white?" And the last lines about the eyes dazzling to the detriment of true "seeing" was perfect. I have so often wished that my friends could be blind for enough time to get their priorities straight. I can't help feeling that if people could get what their eyes see out of the line of fire, they could forget that I am white and that everyone else in this town *must* be or else, and we could accept or not accept each other according to Dr. King's dream. I am used to seeing people in a different light. I have had James's situation before. Again, thank you for an excellent story.

JODY DAY

Dear *Analog*,

Just dropping a line to say that "The Three Labors of Bubba" has got to be one of the funniest and best written stories of the year. Bud Webster has definitely outdone himself, and I hope for more of his stories ASAP.

"The Content of Their Character" was a well written story too, if a bit forced. In reality, however, a seeing-aid for the blind would be one of the *first* applications for a direct-to-brain helmet such as that, probably right after a heads-up-display for combat aircraft.

Keep up the good work,

PAUL BLASE

6430 The Parkway
Alexandria, VA 22310

Dear Drs. Schmidt and Andrews:

It is with some regret that I inform you that your request for funds must be refused. The exceptions to the noninterference rules of time travel you attempt to carve out fall seriously short of the mark. However, you are correct that we must cover the possibility that a wealthy magazine editor and his colleague may have played an important role in creation of the ChronoDialator. (Needless to say, the disaster that destroyed our records of the initial research is/was sufficiently dangerous to prevent the safe exploration of the events by time travelers.)

Thus, we propose the following as an alternative. You should send US $1,000 to the undersigned. We will take the responsibility for investing the money in stocks, horse races, etc., and, after sufficient time has elapsed to grow your initial investment into a fortune, we will return to this time period with, as you suggest, US $1,000,000 minimum for you to invest in time travel technologies. Due to the vagaries of scheduling, and the need for some secrecy in this endeavor, I cannot guarantee a return date other than to say that you should expect us between one and two years after you send the money.

RANDY ROUDA
Visalia, CA

Dear Harry:

In your column "Tidbits" you had some ideas about technology. Looking at it from the perspective of 69

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years, the advances have been remarkable. My working career was spent primarily in and around mining. This industry is a prime example of the benefits of technology. Technology has made possible the production of critical needed minerals from ore bodies that 50 years ago were not even considered as mineral deposits. This advance has benefited the miners as well. The pick and shovel are pretty much relics of the past. Now we have air-conditioned cabs and power assisted controls. He (or she) can now go to work with a reasonable expectation of coming home at the end of the shift in one piece. The most dangerous part of the job now is the freeway getting to and from the workplace.

This technology was developed as it was needed. It was demand driven. It had, and still has, its growing pains, but the point is, when it was needed, it was acquired.

Make a jump to tomatoes. Greenhouses are now being built in conjuction with power plants. The waste heat from the power plant heats the greenhouse and produces tomatoes. Cuts down on use of valuable land, cuts down on pollution, produces needed produce year round. A win-win situation. I have no doubt that as the need for food and fiber increase, the needed technology will evolve to provide it.

You spoke of being out of coal in a "couple of thousand years." When I was in high school, we were told that we had to switch to oil as the coal supplies were almost depleted. Then technology took the coal miner off of his knees in a coal seam and put him in the air-conditioned cab of a monster earth mover, mining seams that were impossible to contemplate 50 years ago.

Enough. As I write, technology is improving every aspect of our life. Some of the transition is painful, but it makes for a better future.

GERALD L. MOSELEY
gpm@ccis.com

The author replies. . . .

Thanks for your comments on my Alternate View column. I appreciate them. As Dr. Julian Simon points out in his book, *The State of Humanity,* (Blackwell Books, Cambridge MA, ISBN 1-55786-585-X), "Conditions are getting better but perceptions are not."

G. HARRY STINE

Dear *Analog,*

When I read Allan R. McCoy's letter where he says, ". . . The reason the woman won her suit is that McDonald's did in fact give her overheated coffee—about 40 degrees Fahrenheit overheated. Seems that you (or in this case McDonald's) can squeeze some more coffee out of the beans by heating the water to about 180 degrees F rather than the more common 140 degrees F. . . ," something did not seem right. So remembering the wise advice that one should never rely on expert opinion when simple arithmetic will do, I decided a simple experiment was in order.

I added a meat thermometer to the coffee pot on my coffee maker. (Hey, we're not talking rocket science here, just kitchen chemistry and physics.)

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Sure enough, after my two mugs of morning coffee brewed, the thermometer read 175 degrees Fahrenheit. After sitting on the warmer for 20 minutes, it read 180 F.

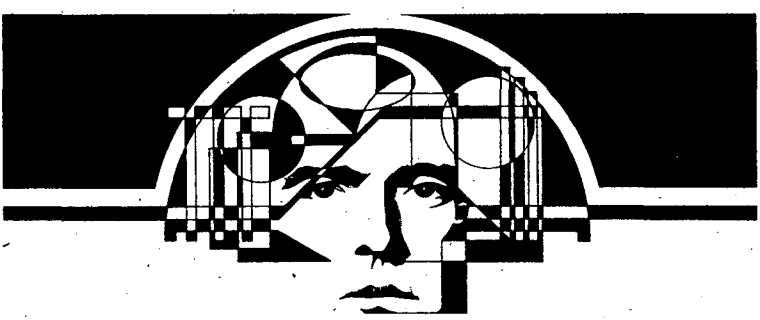
(Full experimental data: Coffee maker is a Mr. Coffee Accel, model #PR12A, 12 "cup" coffee maker. 750 ml water [5 "cups"]. 2-6 "cup" brew cycle.)

For those who prefer authority to experiment, *Joy of Cooking* by Irma S. Rombauer and Marion Rombauer Becker (1964) says, "Remember that any moisture activates coffee and that water between 200-205 F is ideal for extracting flavor without drawing acids."

My conclusion from this experiment is that Mr. McCoy has been fed a line of misinformation. The normal brewing temperature for coffee is just below boiling, and the normal keeping temperature is 180 F, just as McDonald's served it. If the jury was also given this misinformation, then it reflects badly on the American legal system.

BILL FRANTZ

via the Internet. ■



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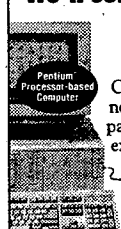

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UPCOMING EVENTS Anthony Lewis

10–12 January

ARISIA 8 (Boston area speculative media conference) at Park Plaza Hotel, Boston, MA. Guest of Honor: R. A. Salvatore; Artist Guest of Honor—Bob Eggleton; Fan Guests of Honor—the Founding Five. Registration—$30 until 15 November 1996, more thereafter. Info: Arisia 8, 1 Kendall Square #322, Cambridge MA 02139. E-mail: arisia@asylum.sf.ca.us OR info@arisia.org

17–19 January

CHATTACON 22 (Tennessee SF conference) at Chattanooga, TN. Guests include Harry Turtledove, Esther Friesner, Tom Kidd, Charles Grant. Info: Chattacon 22, Box 23908, Chattanooga, TN 36422. (404) 578-8461. E-mail: m.dillson@genie.com

24–26 January

CONFUSION 17 (Michigan SF conference) at Van Dyke Park Suite Hotel and Conference Center, Warren, MI. Guest of Honor—Samuel R. Delany; Artist Guest of Honor—Susan Van Camp; Fan Guest of Honor—Joey Shoji; Science Guest of Honor—Mark Shapiro. Registration: $25 until 31 December 1996, $30 at the door. Info: AASFA/ConFusion, Box 8284, Ann Arbor MI 48107. (303) 487-8743.

14–16 February

BOSKONE 34 (New England regional SF conference) at Sheraton Tara, Framingham, MA. Guest of Honor—John M. Ford; Official Artist: Ron Walotsky, Featured Filk Performer—Tom Smith. FanHistoricon, a mini-con dedicated to preserving and recording fannish history will be hosted. Registration: $34 until 19 January 1997, more at the con. Info; Boskone XXXIV, Box 809, Framingham, MA 01701-0203. (617) 625-2311, FAX (617) 776-3243. URL: http://www.panix.com/NESFA/home.html

28 August–1 September

LONESTARCON 2 (55th World Science Fiction Convention) at San Antonio Convention Center, San Antonio, TX. Guests of Honor—Algis Budrys and Michael Moorcock; Artist Guest of Honor—Don Maitz; Fan Guest of Honor—Roy Tackett; TM—Neal Barrett, Jr. Registration until 7 July 1996: $95; supporting $25; children 3-12 $40, children 0-3 FREE (age as of 28 August 1997). This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info: LoneStarCon 2, Box 27277, Austin, TX 78755-2277. (512) 435-7446 (voice), (512) 435-7747 (fax), lsc2@io.com

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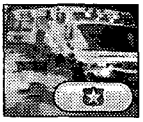
ELECTRONIC REPRODUCTION PROHIBITED

Why pay for cellular phone service if you only want it for emergency use?

The SOS Phone offers a 24-hour call center to connect you with your emergency roadside service, 911 service or family members in the event of an emergency.

The SOS Phone gives you instant access to the emergency service you need, from towing to 911, even a family member or friend.

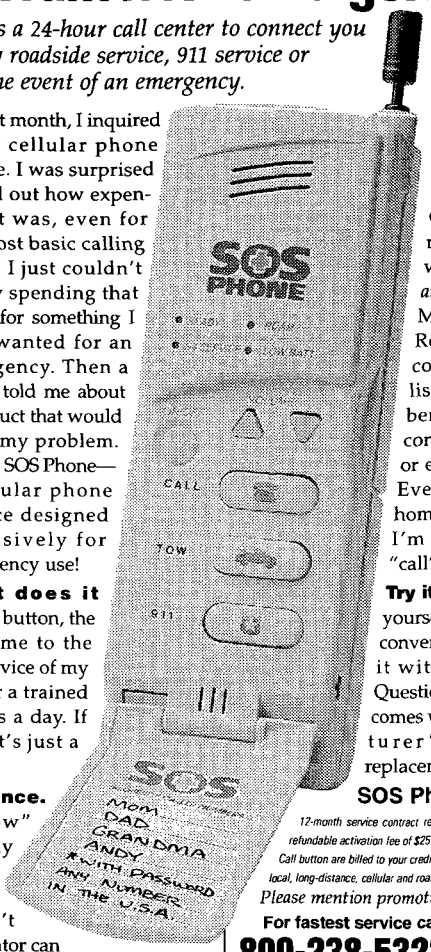


Last month, I inquired about cellular phone service. I was surprised to find out how expensive it was, even for the most basic calling plans! I just couldn't justify spending that much for something I only wanted for an emergency. Then a friend told me about a product that would solve my problem. It's the SOS Phone—a cellular phone service designed exclusively for emergency use!

What does it do? With the touch of a button, the SOS Phone connects me to the roadside emergency service of my choice, a 911 service or a trained SOS operator, 24 hours a day. If I need help, I know it's just a phone call away.

Emergency assistance. By pressing the "tow" button, I'll be instantly connected to my emergency roadside service provider. Or, if I don't have one, the SOS operator can recommend one and dispatch them immediately.

The "911" button connects me to the 911 emergency service in my area—best of all, the call is absolutely free!



Personalized service. Each SOS Phone has a serial number that is recorded at the Call Center. Each time I use my phone, the operators will know it's me calling, *and will greet me by name.* My SOS Emergency Record will appear on the computer screen with my list of 10 most-used numbers and the operator will connect me with the person or emergency service I need. Even if I just want to call home to tell my husband that I'm running late, with the "call" button, I can!

Try it yourself. Why not try it yourself? If you don't enjoy its convenience and security, return it within 90 days for a "No Questions Asked" refund. It also comes with a three-year manufacturer's limited repair or replacement warranty.

SOS Phone . . . . $99 $12 S&H

12-month service contract required for this price. Requires a one-time non-refundable activation fee of $25 and a monthly charge of $9.95. Calls made on the Call button are billed to your credit card at $1.45 per minute. (That rate includes all local, long-distance, cellular and roaming fees.) For outgoing calls only.

Please mention promotional code **1788-AS-1558** .

For fastest service call toll-free 24 hours a day

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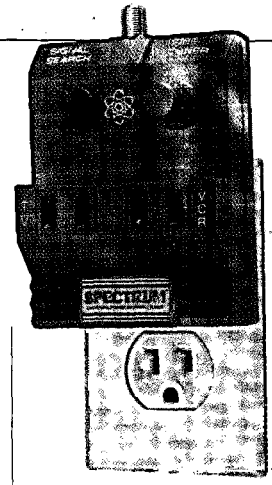
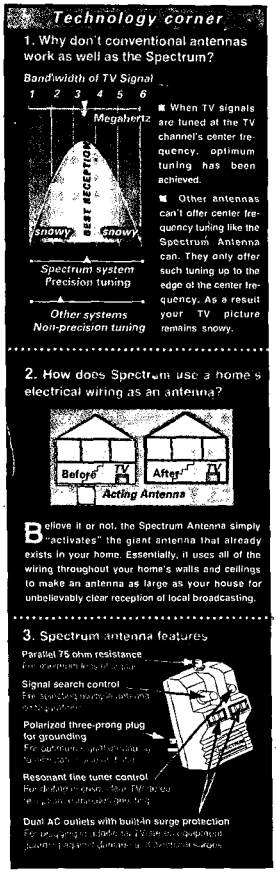
Fifteen years of microelectronic research makes conventional antennas a thing of the past!

This little box uses your home's electrical wiring to give non-subscribers, cable subscribers and satellite users better TV reception on your local broadcast networks!

by David Evans




Technology corner
1. Why don't conventional antennas work as well as the Spectrum?
Bandwidth of TV Signal
1 2 3 4 5 6
Megahertz
BEST RECEPTION
snowy
snowy
Spectrum system
Precision tuning
Other systems
Non-precision tuning
When TV signals are tuned at the TV channel's center frequency, optimum tuning has been achieved.
Other antennas can't offer center frequency tuning like the Spectrum Antenna can. They only offer such tuning up to the edge of the center frequency. As a result your TV picture remains snowy.
2. How does Spectrum use a home's electrical wiring as an antenna?
Before
TV
After
TV
Acting Antenna
Believe it or not, the Spectrum Antenna simply "activates" the giant antenna that already exists in your home. Essentially, it uses all of the wiring throughout your home's walls and ceilings to make an antenna as large as your house for unbelievably clear reception of local broadcasting.
3. Spectrum antenna features
Parallel 75 ohm resistance
Signal search control
Polarized three-prong plug for grounding
Resonant fine tuner control
Dual AC outlets with built-in surge protection

Until recently, the only convenient way to guarantee great TV reception was to have cable installed or place an antenna on top of your TV. But who wants to pay a monthly cable fee just to get clear reception, or have rabbit-ear antennas that just don't work on all stations? Some people just aren't interested in subscribing to cable. Or they may live in an area where they can't get cable and TV-top antennas aren't powerful enough. And what about those people who have cable or satellite systems but still can't get certain local stations in clearly?

Now, thanks to fifteen years of microelectronics research, a new device has been developed that is so advanced, it actually makes conventional antennas a thing of the past. It's called the Spectrum Universal Antenna/Tuner.

Advanced technology. Just imagine watching TV and seeing a picture so clear that you'd almost swear you were there live. Just plug the Spectrum Antenna into a standard AC outlet and plug your TV into the Spectrum. You can remove the unsightly clutter of traditional TV-top devices gathering more dust than television signals. Get ready for great reception. Your TV will suddenly display a sharp, focused picture thanks to its advanced design "Signal Search" and "Fine Tuner" controls.

Who can use Spectrum?

- ***Cable users-You have cable but you can't get certain local stations in clearly.***
- ***Non-cable users-You don't have cable and want the stations to come in more clearly***
- ***Satellite users-You have a digital satellite system but can't get local stations in clearly***

Uses your home's electrical wiring. The Spectrum Antenna is a highly sophisticated electronic device that connects into a standard wall outlet. The outlet interfaces the Spectrum Antenna with the huge antenna that is your home wiring network. It takes the electrical wiring in your house or apartment and turns it into a multi-tunable, giant TV reception station which will improve your TV's overall tuning capability. The results are incredible. Just think how much power runs through your home's AC wiring system—all that power will be used to receive your local broadcasting signals.

How it works. Broadcast TV signals are sent out from the local broadcast station (ABC, CBS, NBC, etc.). They interface with your home's AC power line system, a huge aerial antenna network of wiring as large as your home itself. When the Spectrum Antenna interfaces with the AC line, the signal is sent to its signal processing circuit. It then processes and separates the signal into 12 of the best antenna configurations. These specially processed signals route themselves into 12 separate circuits. The Spectrum Antenna includes a 12-position rotary tapping switch, the "Signal Switch" control, which gathers twelve of the best antenna configurations.

The "Signal Search" offers varying antenna configurations for the user to select from the best signals of all those being sent. The signal then passes through the Spectrum Antenna's special "Fine Tuner" circuit for producing crisp, clear reception.

Risk-free offer. The Spectrum Universal Antenna/Tuner comes with our exclusive 90-day risk-free home trial and a 90-day manufacturer's warranty. Try it, and if you're not satisfied, return it for a full "No Questions Asked" refund.

Limited time offer! We realize that most people have more than one TV in their home. We are offering a special discount on additional Spectrum Antennas so you get great reception on all your TVs!

Spectrum Antenna .....$39 $4 S&H

***Additional antennas just*.....$34 S&H free**

Please mention promotional code 1492-AS-1557

For fastest service, call toll-free 24 hours day

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